

Technical information for paging, SMH and private wireses neitro



- Danger of RF exposure
- Digitally modulated RF signals
- Antenna structure registration
- Enhanced messaging for ESMC
  - Mobile backup batteries

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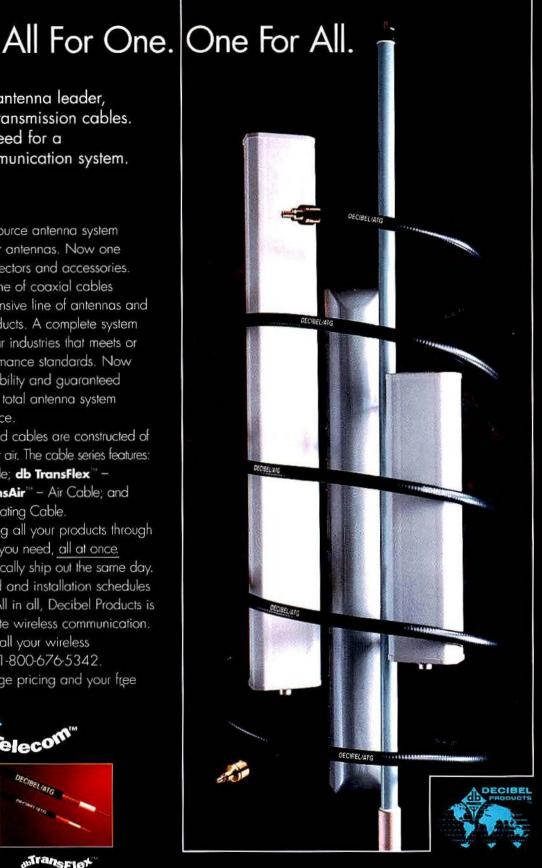
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## E ditorial

## Scanning . . .



### FCC downsizes

The FCC has completed a round of downsizing, but it won't help the agency to fit its headquarters staff into what is expected to be its new office space next year. The square footage of the new headquarters is somewhat less than what the agency currently occupies in and around 1919 M St. in Washington, but the laid-off employees work in offices and monitoring stations outside the Washington area.

Prior to June 1, the FCC's Compliance and Information Bureau maintained 35 field offices and monitoring stations. As of June 1, the number was reduced to 16 offices. The number of bureau employees, many of them engineers, was reduced from 374 to 254.

The number of bureau employees was 512 when one former bureau chief advanced to that position. As the number of bureau employees dwindled, he projected that if the reduction continued at the same rate, by a certain year (2008, I think it was), the last bureau employee would turn out the light and close the bureau for good. That opinion seemed extreme—but was it?

The FCC has closed all 12 of its monitoring stations. Almost all FCC field offices are equipped for monitoring frequencies at VHF and above. The monitoring stations were additionally equipped to monitor signals in the high-frequency (HF) range. Stations were closed in the following locations: Allegan, MI; Anchorage, AK; Belfast, ME; Douglas, AZ; Ferndale, WA; Grand Island, NE; Honolulu; Kingsville, TX; Livermore, CA; Powder Springs, GA; San Juan, PR; and Vero Beach, FL.

Other offices closed by the commission include those in Buffalo, NY; Norfolk, VA; Miami; Houston; Portland, OR; and St. Paul, MN.

OK, what's open?

To begin with, in nine locations affected by office and monitoring station closings, some staff, in most cases two engineers, will remain as resident agents to resolve enforcement and interference problems. Those locations include Buffalo, Houston, Miami, Norfolk, Portland and St. Paul.

Offices that remain in operation include Atlanta (404-279-4621); Baltimore (410-962-2729); Boston (617-770-4023); Chicago (312-353-0195); Dallas (214-767-4287); Denver (303-969-6497); Detroit (313-226-6078); Kansas City, MO (816-353-3773); Los Angeles (310-809-2096); New Orleans (504-589-2095); New York (212-620-3437); Philadelphia (215-752-1324); San Diego (619-467-0549); San Francisco (510-732-9046); Seattle (206-821-9037); and Tampa, FL (813-228-2872).

If you have an interference problem that involves safety of life or property, you should call the office nearest you. For other interference problems affecting land mobile communications, call the FCC National Call Center at 888-322-8255. The FCC previously announced that, upon closing the field offices and monitoring stations, it would make available a toll-free number for interference complaints—and that's the number.

## Spectrum wall chart

The National Telecommunications and Information Administration, an agency of the U.S. Department of Commerce, has issued a wall chart defining spectrum uses from 3kHz to 300GHz. If you would like to obtain a copy, here's how:

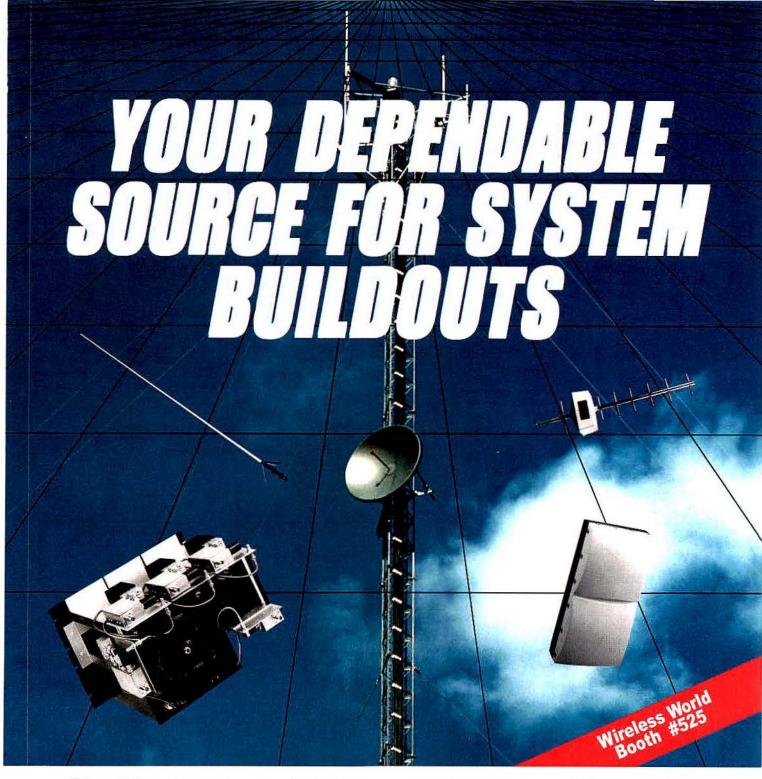
The product name is "1996 Spectrum Wall Chart;" the stock number is 003-000-00652-2; and the price is \$3.25.

Orders can be placed by mail to "U.S. Government Printing Office, Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954."

Inquiries and orders can be placed by telephone and facsimile; Tel. 202-512-1800; Fax 202-512-2250. Fax-on-demand orders can be placed with U.S. Faxwatch at 202-512-1716.

A word about ordering the chart: Some callers have been told that the stock number corresponds with a 1987 version of the chart. A representative of NTIA told us that the Government Printing Office (GPO) was supposed to discard remaining copies of the 1987 chart and replace them with the 1996 chart. Computerized records that GPO representatives access when speaking with callers may not reflect the pairing of the stock number with the 1996 chart. If you are told that the stock number corresponds with the 1987 chart, now you know why.

-Don Bishop



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## C alendar

## October

- 7–9—Wireless Apps, sponsored by the Cellular Telecommunications Industry Association, Bally's, Las Vegas, Contact: 301-694-5243.
- 16–17—Land Mobile Spectrum Refarming & Regulation seminar, sponsored by ENTELEC, Houstonian Hotel, Houston. Contact: Martha Fike, 214-235-0655.
- 30-Nov. 1—WirelessWorld Conference and Exposition, sponsored by Cellular Business and Mobile Radio Technology magazines, Orange County Convention and Civic Center, Orlando, Fl., Contact: Susan Link, 913-967-1969.

## November

- 7–8—Small Business in Telecommunications, regional meeting. Sheraton Suites Market Center, Dallas, Contact: 202-223-8728.
- 14-17—Communications Marketing Conference, sponsored by the Communications Marketing Association, San Diego Princess Resort, San Diego, Contact: Bernie Brownson, 303-371-8182.
- 22—Radio Club of America, Communications Symposium, 87th Anniversary Dinner and Awards Presentation, New York Athletic Club, New York. Contact: Gerri Hopkins, 908-842-5070.
- 18-19—AMTEX, the American Mobile Telecommunications Association's Marketing and Technology Conference and Exposition, Intercontinental Hotel, Miami. Contact: 202-331-7773.
- 18–20—First International Congress on Commercial Trunked Radio, sponsored by the International Mobile Telecommunications Association, Intercontinental Hotel, Miami. Contact: 202-331-7773.

## 1997

## March

3-5-Wireless, sponsored by the Cellular Telecommunications Industry

- Association, Moscone Convention Center, San Francisco. Contact: 202-785-0081.
- 23–26—Energy Telecommunications and Electrical Association, New Orleans Convention Center, New Orleans. Contact: 214-235-0655.

## April

22-24—International Wireless Communications Expo. co-sponsored by Mobile Radio Technology. Las Vegas Sands Convention Center, Las Vegas. Contact: 800-288-8606.

## May

5-7—Vehicular Technology Conference, sponsored by IEEE Vehicular Technology Society, Hyatt Regency at Civic Plaza, Phoenix. Contact: Wendy Rochelle. 908-562-3870: Fax 908-981-1769.

## June

- 2–5—Supercomm, sponsored by USTA and TIA. New Orleans Convention Center, New Orleans, Contact: 202-326-7300.
- 3–5—Canadian Wireless, sponsored by the Canadian Wireless Telecommunications Association, Montreal. Contact: 613-233-4888.
- 16–20—UTC National Conference & Exhibition, sponsored by UTC, The Telecommunications Association, Oregon Convention Center and Red Lion Lloyd, Holiday Inn, and Travelodge Hotels, Portland, OR. Contact: 202-872-0030.

## August

10–14—International Association of Public-Safety Communications Officials (APCO) National Conference, Charlotte, NC. Contact: 904– 322-2500.



## Mobile Radio Technology

Technical information for paging, SMR and private wireless networks

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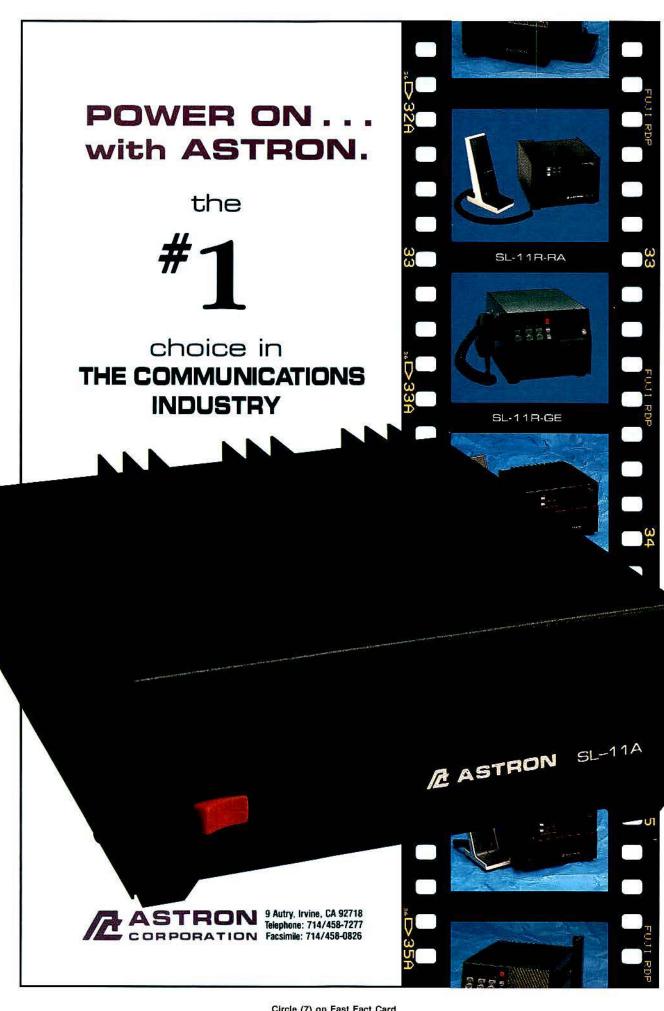




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## echnically speaking

## Troubleshooting 101: Part II

### By Harold Kinley, C.E.T.

Troubleshooting is the science (or art?) of finding the defective section, stage and component of a malfunctioning piece of equipment in the shortest possible time. Almost anyone can replace a defective component, but finding the culprit in a complex circuit is what separates the men from the boys in the shop!

Many years ago, I was doing come CB repair work on a moonlighting basis. A gentleman brought in a CB transceiver, and although I was busy at the time, he convinced me to drop what I was doing to work on his defective transceiver. After about 30 minutes of troubleshooting work, I found the culprit to be a leaky

capacitor. After I showed the customer the problem, he asked how much the repair would cost. After I informed him that the repair charge would be \$20, he advised me to "button up" the radio and not to repair it.

So, I "buttoned up" the radio and charged the gentleman(?) \$15 for the troubleshooting time. I knew he would simply buy a replacement capacitor and replace it himself after I had identified the defective component for him. He had some ability with a soldering iron but not much at troubleshooting. Again, anyone can replace a component, but it takes a real troubleshooter to find the defective component(s).

This month we will look at a couple of troubleshooting techniques that, al-

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DEMOD PROBE

IF AMP

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Figure 1. To use a sinab meter as a signal tracer, just hook the demod probe to the sinab meter input.

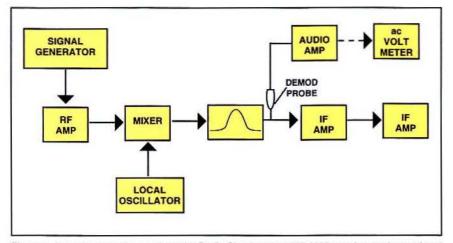


Figure 2. An audio amplifier, such as the Radio Shack model 277-1008, can be used as a signal tracer with a demod probe as shown. An ac voltmeter can be plugged into the phone jack to get a voltage reading as a reference.

though a little unorthodox, are quite useful.

## Signal tracing

Suppose you are troubleshooting a receiver that has a weak (low gain) or dead stage. You can force a high-level signal through the receiver, but the sensitivity is poor. First, the defective stage must be located.

In AM receivers, a simple demodulator (demod) probe can be used in conjunction with an audio amplifier to trace the AM signal through the receiver. Aside from the limiter stages and detector, the FM receiver is no different from the AM receiver. This means that a simple demodulator probe can be used to trace the signal in the FM receiver.

Besides the demodulator probe, an audio amplifier with optional metering is needed. The audio amplifier simply amplifies the *demod* probe output and allows it to be heard in the loudspeaker. To use this method, simply apply a high-level signal to the input of the receiver. The signal must be *amplitude-modulated* at a high level (about 70% to 80%) using a 1kHz tone. By moving the demod probe from input to output of the various stages, the malfunctioning stage can be located. Relative stage gain is indicated by changes in the tone level from input to output.

If you happen to have a SINAD meter with a built-in audio amplifier and a voltage scale with decibel calibrations, so much the better. The demod probe can be connected to the input of the SINAD meter, and the voltmeter can be used as a better indication of stage gain, while the speaker serves as aural indication (if you are simply signal-tracing and not interested in stage-gain measurements).

It is important to keep the input signal level as low as possible to prevent over-loading the audio amplifier or the SINAD meter. The preferred method is to set the RF signal input level just high enough to produce a usable reading at the SINAD meter-audio amplifier with the demod

(continued on page 50)

Kinley, a certified electronics technician, is regional communications manager. South Carolina Forestry Commission, Spartanburg, SC. He is a member of the Radio Club of America. He is the author of Standard Radio Communications Manual: With Instrumentation and Testing Techniques, which is available for direct purchase. Write to 204 Tanglewylde Drive, Spartanburg, SC 29301.

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## Enhanced messaging gives advantages to ESMR users

ESMR carriers using Motorola's integrated dispatch enhanced network technology can add a voice processing system to offer the voice messaging that many business users expect with today's telecommunications services.

## By Tom Keller and David Steier

Users of enhanced specialized mobile radio (ESMR) technology often need voice messaging that two-way dispatch alone cannot provide. Everyone who uses telecommunications for business faces the same problems: missed calls, forgotten messages, busy signals and "telephone tag."

Conventional voice messaging features, such as voice mail, voice messaging, message delivery, direct dial, automatic callback, short message notification and single-number service can offer advantages to ESMR users. They can receive accurate messages, listen to the caller's voice and

receive the complete message. Voice messaging offers privacy—only the subscriber hears the message intended for him.

For an ESMR user, short message notification is especially valuable. Custom text messages can be displayed on the two-way handset, such as: "Please call 623-1111," "Caller holding" or "Voice mail: 2 new, 3 saved messages." In addition, when someone places a call to an ESMR telephone number, the enhanced services platform can connect the call to a dispatch center where the caller has the option of leaving a detailed text message. An operator then types in the text message; the system delivers it to the ESMR subscriber; and the message is displayed on the handset. An

enhanced services voice messaging platform can be used with ESMR technology to let ESMR operators provide such advanced communications technologies.

## Operational description

For ESMR use, service providers install the voice processing platform with their mobile telephone switching offices (MTSOs), where the voice processing system is connected to the mobile switching center (MSC).

Depending on the nature of the call, calls are processed in one of two ways: voice mail only and enhanced services. Enhanced services can include voice messaging, short message notification, fax mail and one-number service that allows subscribers to combine all of their phone numbers—ESMR telephone, private branch exchange (PBX) extension, home phone and pager numbers—into one number, providing a single point of contact.

## Configurations

For ESMR, it is typical to connect the voice processing system and the T1 or E1 public switched telephone network (PSTN) lines to the MSC. (See Figure 1 at the left.) The MSC then is connected to the home location registry (HLR) and the short message service center (SMSC), and to the voice processing system by T1 spans, SS7 connections or both. SS7 signaling is accomplished either by using an extracted data channel on the T1 or E1 trunk, by

Keller is an applications engineer for new business development with Glenayre Technologies, Atlanta. Steier is an applications engineer with Glenayre Technologies, Charlotte, NC. This article summarizes how an enhanced services platform, such as the company's modular voice processing (MVP) system, can connect into an ESMR platform. The one-number service mentioned in the article is the company's Constant Touch service.

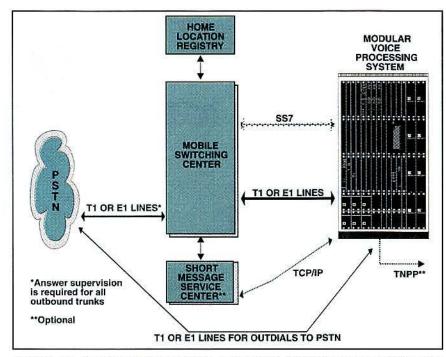
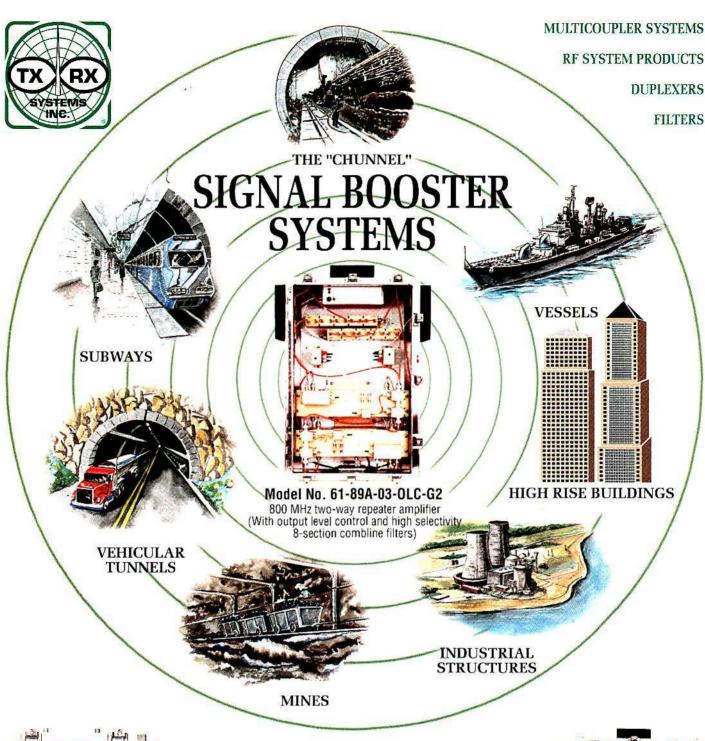


Figure 1. For enhanced specialized mobile radio (ESMR), it is typical to connect the voice processing system and the T1 or E1 public switched telephone network (PSTN) lines to the mobile switching center.

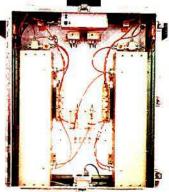




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Model No. 61-65-91276 UHF two-way repeater amplifier (With output level control and high-isolation combline filters)

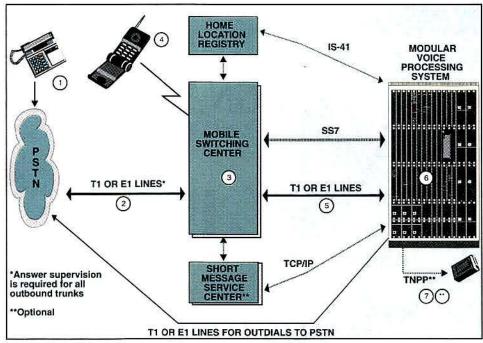
V.35 or by a similar data communications link. The MSC also connects with the voice processing system by T1 or E1 spans for callprocessing. The voice processing system in turn connects to the SMSC by TCP/IP connections.

Typically, the voice processing system has a direct T1 span connected to the PSTN for notification outdials, fax delivery and one-number service outdials. An RS-232 connection to a paging terminal may be present in the system, but is not required. The protocol for this link is Telocator Network Paging Protocol (TNPP).

## Voice mail call processing

Often, ESMR service providers offer either call answering or voice mail to their subscribers. To alert a subscriber to a new message waiting in the voice mailbox, the MSC provides a Figure 2. The call flow for voice mail (see text). message waiting indication

(MWI) using either short message notification via the handset or an outdial (message delivery) to the mobile hand-



set. Additionally, a TNPP link can be established from the voice processing system to a paging terminal.

The call flow for voice mail, shown in Figure 2 above, is as follows:

1. The caller phones the ESMR



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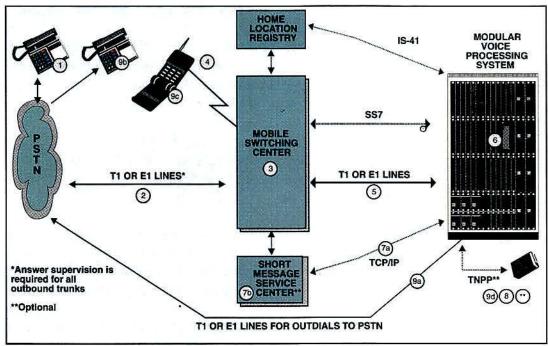


Figure 3. An example of the enhanced services call flow-in this case, one-number service (see text).

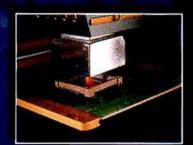
subscriber's (direct inward dial) DID number.

- 2. The call is switched to the MSC over T1 or E1 lines.
- 3. The MSC rings the subscriber handset.
- 4. If the subscriber answers, the call is completed.

- 5. If the line is busy or the caller does not answer, the MSC recalls the line and performs an internal database lookup. The MSC then determines that the subscriber has voice mail and transfers the call and appropriate signaling information (signaling over an SS7 link) to the voice processing system over T1 or E1 lines.
- 6. The call is routed into the subscriber's mailbox, and a numeric, text or voice message is taken.
- 7. The voice processing system then sends a packet to the SMSC over the TCP/IP link to have the center deliver the

short message to the subscriber's handset. An optional TNPP link to a paging terminal sends a numeric, alphanumeric





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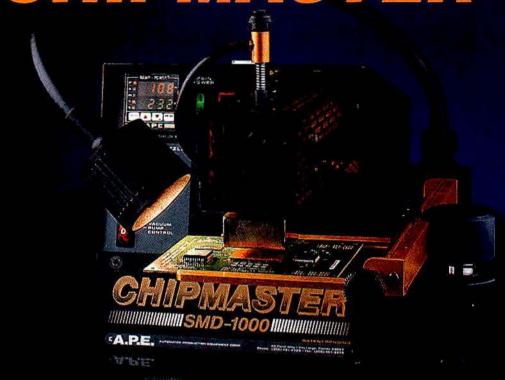


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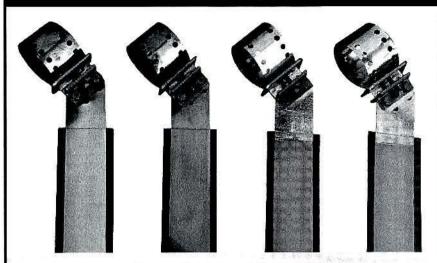
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or tone-only page to the subscriber.

## Enhanced services call processing

Enhanced services include voice mail. short message notification, fax mail (optional) and one-number or single-number service. Single number service allows the subscriber to consolidate business, pager, mobile, fax and home phone numbers into one number. Figure 3 on page 14 shows the enhanced services call flow. For example, a typical one-number call flow is as follows:

- 1. The caller phones the mobile subscriber's DID number.
- 2. The call is switched to the MSC over T1 or E1 lines.
  - 3. The MSC rings the subscriber's handset.
- 4. The subscriber answers, and the call is completed.
- 5. When a busy signal or a "ring, no answer" is encountered, the MSC re-calls the line and performs an internal database lookup. The MSC then determines that the subscriber has enhanced services and transfers the call and appropriate signaling information (signaling over an SS7 link) to the voice processing system over T1 or El lines.
- 6. The call is routed into the subscriber's mailbox, and the voice processing system executes the subscriber's enhanced service application (i.e., one-number service).

7a. The voice processing system sends a short message packet to the SMSC over the TCP/IP link.

7b. The SMSC then sends a short message to the handset-for example, "A caller is holding."

8. An optional TNPP link to a paging terminal sends a page to the subscriber.

9a. The one-number service notification schedule activates. The MVP places a call to the predetermined numbers on the schedule.

9b. A land-line notification number (such as office and home).

9c. A mobile number. The voice processing system receives call-result information via the SS7 link and verifies whether or not the mobile phone was called. If the mobile phone was forwarded to the voice processing system, the system calls the mobile number.

9d. A pager number.

By incorporating the technology of enhanced services platforms, ESMR service providers can offer customers additional voice messaging services traditionally offered by mobile or wireline service providers. In so doing, ESMR service providers can also enjoy the benefits these carriers realize from enhanced services-increased revenue and decreased churn.

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## 3:1 time division supports premium digital voice quality

Using an 8kbps vocoder, an integrated digital service delivers enhanced voice quality for wireless telephone calls. The service retains 6:1 time division for high-capacity integrated dispatch and paging.

### By David Wangrow

In today's high-demand wireless communications market, technologies must be evolved continually to meet customer needs. That is why, two years after introducing the Integrated Digital Enhanced

The 3-to-1 integrated digital service portable serves as a two-way radio ...

Network (iDEN) as a high-capacity integrated digital service, we have introduced an optional enhancement that delivers premium-quality telephone interconnect communications.

When we deployed the high-capacity integrated digital service as the first fully digital 800MHz system that integrates four wireless communications services for mobile workgroups (full-duplex telephone interconnect, voice dispatch, alphanumeric paging and circuit data transmission), the efficient use of spectrum was crucial. At the time, service providers such as Nextel Communications, McLean,

Wangrow is director, iDEN Infrastructure Product & Release Management, Motorola Land Mobile Products Sector, Schaumburg, IL. Motorola manufactures a high-capacity integrated digital service under the name Integrated Digital Enhanced Network (iDEN). The company's 3-to-1 integrated digital service portable handset is called the i370.

VA, held a relatively small number of 800MHz frequencies.

With this in mind, the integrated digital service was designed to use a 6-to-1, time-division, multiple-access (TDMA) format that provides six communications paths per 25kHz radio channel. The integrated digital service system, based on a

> number of proven RF technologies, originally was deployed using a 4.2kbps vocoder (voice coder) that samples and digitizes voice signals to allow six time slots per 25kHz radio channel.

offer significantly enhanced audio quality where market conditions dictate and where spectrum is available.

Pledging to develop the enhancement, called "iDEN 3-to-1," within one year, our integrated digital service group defined the foundation for the new design. The 3-to-1 service uses a new TDMA vocoder that reduces the number of voice slots allotted per 25kHz channel from six to three. The reduction in voice slots allowed the use of a new 8kbps vocoder. The 8kbps vocoder doubles the voice sampling rate of the existing 4kbps vocoder

and improves the overall richness and tone of telephone interconnect calls. (See Figure 1 on page 20.)

The 8kbps vocoder, when combined with advanced forward-error-



Over time, though, market conditions changed. Nextel, now the largest provider of integrated digital services in the United States, acquired additional 800MHz frequen-

cies, freeing it to explore alternatives that not only offer spectral efficiency, but also enhanced digital voice quality. These market needs propelled the enhancement to the integrated digital service.

## Meeting customers' needs

In April 1995, we teamed up with Nextel to evaluate ways to improve the integrated digital service's voice quality beyond its original design. These discussions ultimately resulted in our commitment to develop an optional vocoder enhancement that would enable carriers to



and it displays paging messages.

correction, achieves improved audio quality, even in the most challenging conditions of low signal strength and high noise. Forward error-correction is a system of error control for data transmission that enables the receiving device to detect and correct bit errors.

For two-way dispatch applications, often called "instant conferencing" and "wireless intercom," the integrated digital service continues to use six time slots to most efficiently use valuable RF spectrum.

Given the reduced communication pathways of the 3-to-1 design, developers

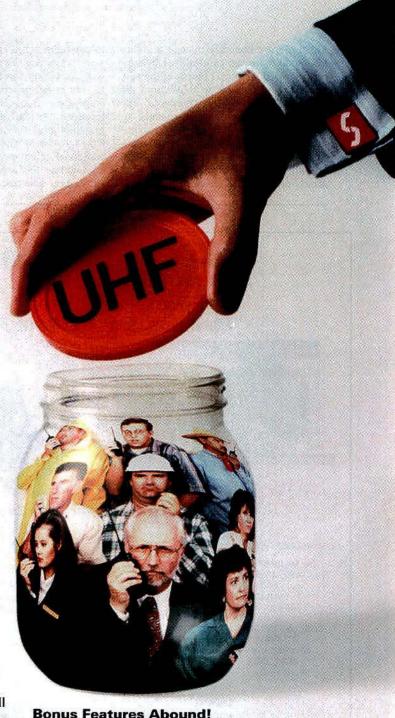
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The heart of the system, the SmarTrunk II Controller, offers such features as programmable call limit timers on a per user basis, radio kill for non-paying users, and the storage of complete call record accounting information. Custom trunking logic boards are available for a wide range of mobile and portable radios.





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had to ensure the infrastructure's ability to support increased call traffic. Developers decreased the power output of the new 3-to-1 digital portable to 0.6W from the original 1W 6-to-1 Lingo portable. The changes in power output and channel capacity to the subscriber unit require modifications in network design to accommodate increased frequency re-use patterns.

With the potential for increased traffic, marketing and engineering teams needed to determine whether additional cell sites were necessary. They considered issues such as market forecasts for subscribers, as well as the system's effect on the coverage area's frequency plans and antenna locations. During beta testing of the integrated digital service 3-to-1 system in Chicago during the first half of 1996, additional cell sites were installed to accommodate the anticipated increase in subscribers and frequency re-use.

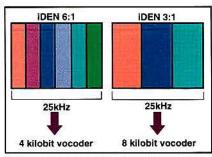


Figure 1. TDMA channel width comparison.

We applied key quality control concepts at all stages of development and deployment to meet goals for integrated digital service 3-to-1 under the tight time frame. Special teams were formed to address a number of issues including voice quality, RF propagation, network performance, handover optimization, and deployment logistics and planning. We implemented a rigid "Q-Gate process," which consisted of establishing a series of required quality gates, or scheduled

During the first half of 1996, we conducted lab and field tests of integrated digital service 3-to-1 that were among the most extensive in our company's history.

check points, that had to be passed before advancing to each product development stage. Another quality control process, called the Quality Research Survey (QRS) approach, allowed engineers to resolve software issues during lab and field tests.

After completing the documentation and design work needed for the 3-to-1 enhancement, a beta application and first office application were completed in March 1996. The general market release was completed on time, as initially promised in April 1995. (See Table 1 on page

## Testing and user satisfaction

During the first half of 1996, we conducted lab and field tests of integrated digital service 3-to-1 that were among the most extensive in our company's history. A series of mean opinion scores (MOS) tests were conducted with men, women and children who listened to voice

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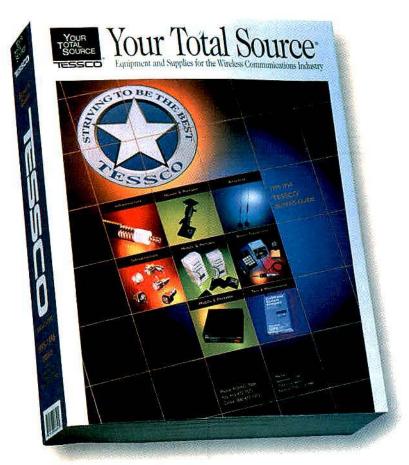
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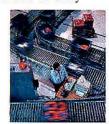
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Photo 1. Motorola's integrated Digital Enhanced Network (iDEN) 3-to-1 portable is called the 1370

samples received on 3-to-1 and 6to-1 handsets, as well as other wireless devices. The audio samples were recorded in a vehicle traveling in a 100-mile area using an "acoustical ear" that was attached to the portable unit. An independent testing agency for digital audio testing scored the audio samples on digital audiotape.

The results exceeded expecta-

tions. The 3-to-1 portable repeatedly ranked as high in audio quality as other digital alternatives, and often even better.

## 6-to-1 performance improvements

While developing the 3-to-1 enhancement, we worked to significantly improve

ACTION	TARGET	STATUS
Motorola agreed to enhance IDEN from 6:1 to 3:1	4/4/95	complete
Technical requirement document complete	6/1/95	complete
Beta office application	2/2/96	complete
First office application (FOA)	3/1/96	complete
General market release	4/30/96	complete
Begin commercial roll-out (Nextel)	6/30/96	complete

the performance of the original integrated digital service technology. Through a series of major software loads to infrastructure and subscriber equipment, as well as system optimization, 6-to-1 networks now perform on par with other wireless digital systems in the key areas of dispatch voice quality, system reliability and system access. (See Table 2 above right.)

The 6-to-1 system continues to be commercially available and implemented

Table 2. iDEN 6:1 system perfor	
	May 1996
System reliability	
- system down time (software)	≈0.03%
System access	
- daily blocked	<2%
Voice quality	
<ul><li>dispatch rated "good/excellent"</li></ul>	85%

around the world. Carriers in international markets often view the 6-to-1 alternative as favorable because it takes maximum advantage of fragmented, scarce RF spectrum.

## New generation of products

Today's customers expect greater portability and smaller products, so we developed a pocket-size digital portable as the first 3-to-1 subscriber unit that integrates three communication services. (See Photo I above left.) This multiservice unit, weighing just over eight ounces, is about half the size of existing integrated digital service subscriber products. It is the smallest, most compact unit on the market today performing telephone interconnect, voice dispatch and alphanumeric paging services in one device, using a common platform. A mobile unit has been introduced to augment the line of 3-to-1 products.

### Future of integrated digital service

With the commercial introduction of 3-to-1 technology in June 1996, carriers have a choice of technologies based on their needs. Throughout all stages of development and testing, we maintained baseline performance criteria and compatibility between 6-to-1 and 3-to-1 technologies. The 3-to-1 enhancement delivers voice quality for telephone communications that is equal to or better than any other wireless digital communications alternative.

About 2,500 integrated digital service cell sites are in operation. They have the capacity to serve more than one million subscribers worldwide. More than a quarter-million integrated digital service subscriber units also are in use.

Integrated digital service is the technology of choice for numerous wireless service providers, including Nextel and Atlanta-based Southern Communications in the United States, as well as carriers in Canada, Japan, Israel, China, Singapore, Colombia and Argentina. In June 1996, Nextel announced a commitment to purchase \$117 million worth of additional integrated digital service equipment, allowing it to deploy the 3-to-1 capability in test markets including Chicago, Detroit, Denver, Atlanta and Boston.



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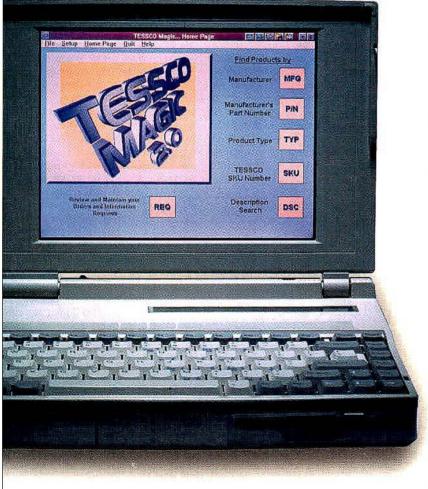
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## Battery basics for mobile communications power backup

Batteries are an often-overlooked element in today's mobile communications uninterruptible power supply (UPS) system. As technologies become increasingly sophisticated, so too must the batteries inside every UPS.

## By Kalyan Jana

Power loss in a mobile communications system can be disastrous for a business or organization relying heavily on such service. Whether it be the loss of two-way-radio service at a small business or an airport radiopaging system going down, operations can come to a sudden halt without mobile communications capabilities. Fortunately, today's high-performance rechargeable batteries keep their systems operating without in-

terruption when traditional power sources fail.

In recent years, technological advancements in the industry have progressed at a skyrocketing pace. With these new technologies, the requirements of uninterruptible power systems (UPS) and the batteries that power them have become more crucial and demanding. Considering the tremendous amount of critical data traveling over communications lines today, having the highest performance battery inside a UPS is pivotal in avoiding power disasters.

Today's battery performance requirements for this industry include:

► Extreme temperature capability — Instead of being pampered in an environmentally controlled location, back-up bat-

Jana is western product support manager at Hawker Energy Products Inc., Warrensburg, MO. The company makes the pure-lead, thin-plate technology described in the article using a proprietary and highly automated manufacturing process (the Genesis and Cyclon batteries).

teries are now distributed throughout the mobile communications network in rugged and remote environments where controlled temperatures are simply impossible. More mobile communications functions are moving out of the central office and into the field, taking their need for high performance battery back-up power with them.

Batteries using pure-lead, thin-plate technology can perform better in both high- and low-temperature situations than traditional lead-acid, thick-plate technology.

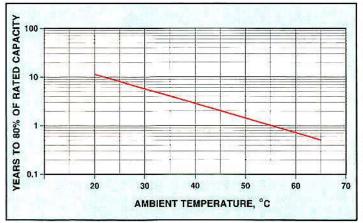


Figure 1. The temperature effect on pure-lead rechargeable battery life in standby applications.

At high temperatures, the chemical reaction in a battery that causes aging (grid corrosion) is accelerated. Pure-lead technology resists this chemical reaction more effectively than conventional lead-acid, thus allowing a battery to have a longer service life. In communications applications, a battery with long service life means fewer replacements and greater reliability. (See Figure 1 above.)

At low temperatures, the ease at which a battery discharges and recharges its power depends on its internal resistance and is an important consideration. A battery can more fully discharge and recharge its power when it contains thinner plates (and thus additional plates and greater surface area). When temperatures drop, a battery with thinner plates can recharge quickly, whereas a battery with thicker (and thus fewer) plates takes longer to recharge. This becomes critical in common emergency situations, such as long-term power outages. A company will typically need to quickly recharge remotesite batteries with a gas-powered generator to quickly return the back-up system

to its full ready status.

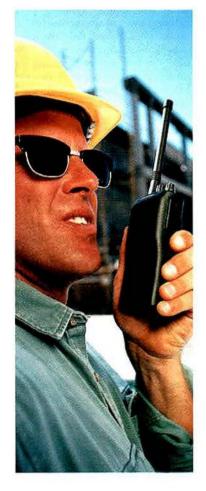
Batteries with thinner plates mean the size and weight of the battery can be reduced. At discharge rates of less than 30 minutes, size and weight can be reduced by as much as 30% compared to batteries with thicker plates. This is an important consideration because space is at a premium in almost all uninterruptible power supply (UPS) locations.

► Fast recharge capability— Even in controlled situations where a depleted battery immediately begins charging when regular power is restored, it is crucial that the

battery recharge quickly to prepare for any further outages. A battery with more, thinner plates can recharge rapidly. A battery with fewer, thicker plates takes longer to recharge, which increases the risk of the battery not being ready for its next disaster-avoiding duty.

When recharging batteries quickly, overcharge resistance becomes a big concern. To avoid overcharge resistance, a battery must use a blend of chemistry and design to recombine the gases formed within the battery cell during overcharge.

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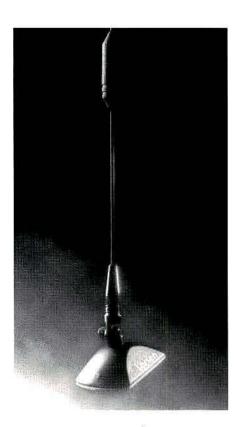
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▶ Maintenance-free — With a 100% maintenance-free battery, sometimes called "fit and forget," a mobile communications company spends no time or money maintaining the battery. One attribute that makes a battery particularly maintenance-free is hardened, copper-alloy terminals that eliminate the need for periodic retightening. Not only does this eliminate maintenance, but UPS designs can be simplified because batteries no longer have to be regularly accessible for service.

▶ Reliability — As noted earlier, reliability is a big concern for batteries used in mobile communications applications. Battery backup requirements may be greater in remote installations because they often are more vulnerable to utility power loss than central offices. It also may take more time to restore power in remote locations where back-up generator support is unlikely to be readily available.

Pure-lead technology effectively resists the natural chemical reaction that causes battery aging. Pure-lead batteries have a longer service life and can complete more cycles of discharging and recharging.

► Safety — Backup batteries found in traditional office environments and central stations also present certain safety concerns that must be addressed. Two of these concerns are flame retardancy and the ability to install batteries close to sensitive electronic circuits.

It is important to use a battery that is packaged in a flame retardant, UL 94-VO rated case. A flash arrestor is a desirable safety feature. The term *valve-regulated lead acid* (VRLA) identifies such a battery equipped with mechanical safety vents that can open under excessive overcharge.

▶ Recovery from overdischarges — An important capability of any rechargeable battery used for backup power in a mobile communications application is its recovery from overdischarge. Overdischarge occurs when a battery is left in a discharged condition for an extended time. This creates a phenomenon called internal sulfation, which can cause permanent damage to the performance of conventional lead-acid rechargeable batteries.

Fortunately, the addition of tin to purelead technology offers greater protection against performance loss due to sulfation. In fact, pure-lead technology meets the stringent requirements of the German DIN\* Standard for overdischarge recovery.

## New applications for batteries

As technological advancements in the

\*Deutsche Industrie Normenausschus, or German Industry Standard. mobile communications industry continue to provide new services and expanded capabilities, the necessity for high-performance batteries will increase. Two particular applications on the horizon—utility metering and security systems—pose interesting new requirements for back-up power systems and their batteries.

▶ Wireless utility metering — Not only can wireless utility metering save the utility and its customers money, it allows more data to be collected. This additional data includes load profile, time-of-use metering, demand metering and immediate power interruption information. Meanwhile, the system must use a high-performance UPS and rechargeable batteries to back up this valuable data.

Wireless utility metering starts with a small module that plugs into the meter and collects data on the customer's power use. Every five minutes, the module transmits the data via radio waves to a small computer mounted on a utility pole. One of these computers collects data from meters within a quarter-mile radius.

The computer then uses a different radio frequency to pass the data on to a base station no more than nine miles away. The base stations send the data to the utility via microwave, fiber-optic cable or dedicated phone lines.

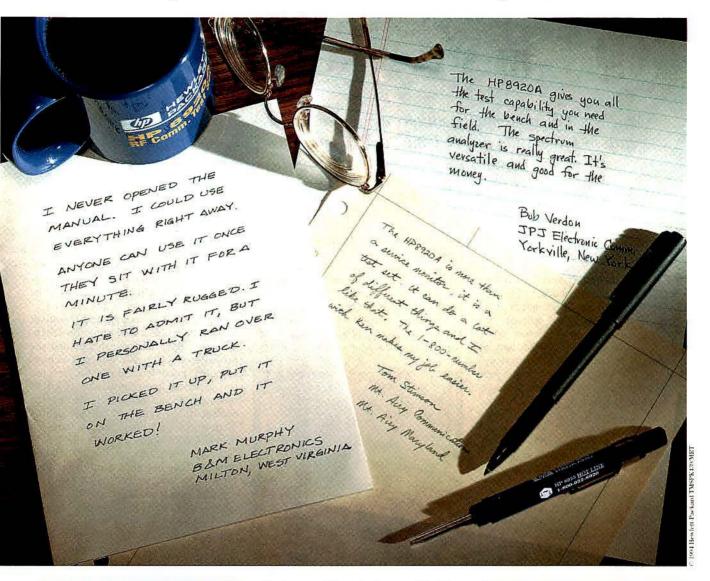
▶ Wireless security and fire alarm systems — Another new application for battery backup in mobile communications is wireless security and fire alarm systems.

In the remote location where neither power nor phone service is available, (or in the event power, phone service or both are cut to a home or business), the security and fire alarm systems must operate normally. Under this condition, the highperformance rechargeable batteries and the UPS are critical.

## Conclusion

Batteries are an often-overlooked element in today's mobile communications UPS system. As technologies become increasingly sophisticated, so too must the batteries inside every UPS. The everincreasing amounts of data traveling across mobile communications lines demands that high-performance batteries be specified. Far too many disasters have occurred when not enough consideration had been given to using batteries specifically built for each particular application. Pure-lead batteries offer the critical backup power necessary for mobile communications products and services.

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## Installing radios in street sweepers

When installing communications equipment in sweeper vehicles, take extra care to protect the power leads and connections. Plan the installation for radio use from either side of the sweeper.

## By Donald E. Koehler

Another "invisible" service vehicle, often seen but almost ignored, is the ubiquitous sweeper truck. These purpose-built vehicles are a collection of different systems, and they come in two general types, open loop and closed loop. Both may be equipped with communication systems. The following information explains how each system works and suggests strategies for installing radio equipment in each.

### Open loop

Open loop sweeper systems are complex machines. Inside the shell at the back are a drive engine, water tank, conveyer belt, waste capture bin and several powered brushes. A complex hydraulic drive and control system orchestrates these parts to clean a wide variety of surfaces efficiently. As the sweeper moves down the road, water, pumped under pressure, is emitted from directed spray heads to wet the surface. Powered side brushes force loose material to the center line of travel, where a large brush in the rear moves the material up and onto a conveyer belt.

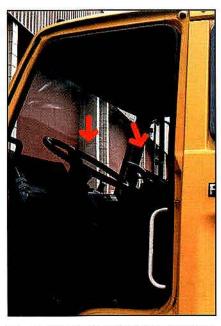
This belt conveys material to a collection bin. The bin can be raised above the bed of the sweeper as much as 20 feet to allow tipping the bin and emptying it into a dump truck. This complex process is powered by a rear-mounted engine.

The open loop refers to the collection bin being open to the air; no real dust control is provided.

## Closed loop

The closed loop system also wets the road surface and uses powered brushes to

Koehler is the owner of Communication Specialties, Anchorage, AK. move loose material to the center line of movement. At this point, a high-powered vacuum pulls the material into an enclosed container, which is normally dumped in a controlled area. Control of dust and particulate matter is the big plus in this type of system. A second engine powers the brushes and a fan, What does all of this mean to the installation technician? Plenty!



There are two steering wheels in each system, so the driver must have access to common controls from either side of the vehicle.

Both systems have extensive hydraulic power and control systems. This means that the forward-hinged operator's cab and the area under it and the frame are stuffed with piping. Further, the operator's cab has two steering wheels and a center-mounted drive engine cover. The roof of the cab usually supports a set of clearance lights and, if the sweeper is

used at an airport, a set of strobe lights. Fortunately, the vehicle's batteries usually are located in an accessible, frame-mounted box. With some planning, installing radio equipment actually can be simple.

For best results, assume that the driver will use both operator positions on a regular basis. Because the cab tips and the propeller-drive-engine cover is centermounted, possible locations for the control head, the transmit-receive (TX/RX) unit or both are limited. Mounting the control in the center of the cab ceiling often works well. I am reluctant to mount heavy TX/RX units on the ceiling of a cab, for safety's sake. If your TX/RX unit does not have a remote head, try mounting it on the rear wall of the cab, with the controls facing up. In either case, an extended-length mic cable should be ordered and installed.

The speaker can be ceiling-mounted in the center rear of the operator's cab. These trucks are noisy, so consider separate speakers if the operator indicates a problem hearing the radio. This portion of the installation yields to a simple solution, and the power and antenna cable runs should be almost as easy.

Mounting the antenna on the roof, away from strobes and clearance lights, is almost always preferred. Glass-mounted antennas are another good choice, with the added bonus of no holes in the roof.

Installing the power leads, on the other hand, could prove to be a bit more difficult. Because the cab tips forward, two problems may occur, one with the power leads, and the other with the power itself. As you route the power cable, be sure that any slack that forms in the cable when the cab closes is protected from damage. A simple loop of rubber or a small spring will help to keep these wires under control. Protect this cable run from chafe, and keep it away from the hydraulic lines

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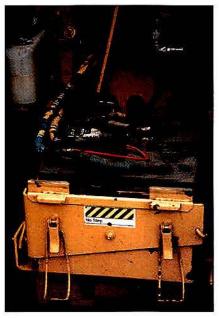
LOCKHEED MARTIN



Mounting the control head in the center of the cab's ceiling often is the best choice.

because the piping can become quite hot while the machine is in use. You cannot count on the vehicle body to provide a ground return path from the equipment. To ensure a solid power supply, run both a positive and negative lead directly to the battery. Check the battery voltage while the system is running, just to be sure.

As always, fuse both sides of the power cable and use a low-voltage cutout or a magnetic switch to protect the communications equipment from motor-induced transients. Generally, using the battery that supports the rear-mounted subsystem engine is a bad idea. This subsystem's voltage regulation may not be as good as the propeller engine's system. Cover all



Access to battery power in sweepers usually is excellent. Be sure to protect battery connections with a waterproof coating.

connections with a coating to protect them from wet or flying material. Check all of the wiring often for corrosion, abrasion



Antennas that are mounted on the roof must be clear of the strobe lights.

and heat damage. Record all wiring and fuse sizes in the vehicle maintenance records.

To make the installation process easier, raise the waste bin fully to permit better access to all areas of the frame. With the cab tipped up, too, the installation goes faster. Caution: make sure all mechanical locks are in place and operational. Even when empty, the waste bin weighs enough to cause the hydraulic lines to bleed back through worn block valves. Do not take chances with safety. If you are in doubt, have a vehicle maintenance technician show you how to set the safety locks and check to be sure they are working properly. Never work on a system unless the

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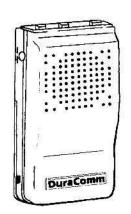
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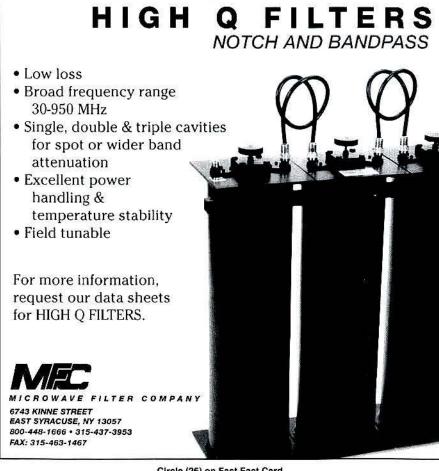


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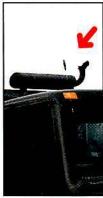
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Here are two possible locations for glassmount antennas.

bin is empty and free from contaminates that may be toxic. Check with the operations supervisor if there is any doubt.

### Static noise

One last issue may not be a problem in all areas of the country. While the sweeper system is operating, static (system noise) can be generated-depending on the material moved and climatic conditions. Should this type of static become a big problem, a simple, stiff, grounding strap may be all that is needed for a cure. If static persists, the source may be one of the drive belts, the conveyor belt or material movement within the waste bin. No easy cure exists if all the subsystems are within normal limits or if extremely dry, fine material is being recovered. Generally, though, static noise is a short-term problem determined by recovered materials. Work with the vehicle maintenance technicians to check drive and conveyor belts because these are dangerous when in operation.

Installation of communications equipment in sweeper vehicles can be straightforward and simple, as long as you take care to protect the power leads and connections. Making it possible to use the radio from both sides of the sweeper necessitates longer mic cables and careful placement of speakers and control heads. Unusual noises may be generated by static from swept materials or sweeper subsystems, in which case working with maintenance personnel is the key to resolving the problem safely. The final professional touch in an installation is recording the installation details in the vehicle maintenance records.

Thanks to Fred Rochelle and Dwayne Aldridge from the Municipality of Anchorage fleet services division. Also thanks to the 3rd Wing, Elmendorf AFB, Civil Engineering Squadron.

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## FCC RF exposure standards: Answers and questions

Bowing to Congress, the FCC has set standards for regulating the level of RF radiation to which the public (as well as others who are expected to be aware of the risk) is exposed. Some burden of compliance is likely to fall on the radio licensee.

## By Robert H. Schwaninger Jr.

After years of study, and round upon round of comments, the FCC has finally released its *Order* on the environmental effects of radio-frequency (RF) radiation (not coincidentally, before the deadline created by Congress). The *Order* creates standards for allowable field strength and RF absorption levels by humans. (*Report and Order* in ET Docket No. 93-62.) The decision answers many questions while creating even more.

Although the FCC's Order is long on discussion, it is short on clear definitions in many areas, making comprehension and application difficult. I will attempt to provide some guidance, while admitting that no RF environmental engineer helped with this writing. Apologies to the white lab coat boys everywhere.

In my defense, the FCC also deferred to the Environmental Protection Agency (EPA) and the Food and Drug Administration (FDA) in the *Order*. The FCC claimed that it did not want to be involved in health and safety issues, but it acknowledged its responsibility in setting forth RF exposure guidelines.

If the following information lacks any necessary specifics, please be patient. The *Order* refers to the future FCC Office of Science and Technology OST Bulletin No. 65 again and again as the document that would set forth the approved methods of testing and reporting measurements. There are answers to questions beginning with "what," but few that explain "how."

## Standards

The FCC used the standards set forth

Schwaninger, MRT's regulatory consultant, is a partner in the Washington, DC, law firm Brown and Schwaninger. He is a member of the Radio Club of America.

by ANSI/IEEE (C95.1-1992), which created maximum permissible exposure (MPE) limits for electrical and magnetic field strength and power density for transmitters operating between 300kHz and 100GHz. The MPE limits were intended to set standards for exposure quantified by the specific absorption rate (SAR). Stated simply, the MPE was intended to limit the amount of energy permissible for exposure to human tissue and absorbed over time; therefore, the standards consider power density, pulse duration, distance, tissue weight and exposure opportunity.

The FCC allows higher levels of emissions when the people who may be exposed should be aware of the potential dangers.

Focusing on the last of these criteria, the standards differentiate between "occupational/controlled" environments and "general population/uncontrolled" environments. Again, stated simply, the FCC allows higher levels of emissions when the people who may be exposed should be aware of the potential dangers, such as radio equipment workers and site operators. Members of the unknowing general public are provided with greater protection, presumably because they would not make an informed choice to be exposed to RF radiation sources. In law, this is called "informed consent." Telecommunications workers have given it, and the public hasn't.

Briefly, the standards are as follows: For occupational/controlled environments, the MPE is 0.4W/kg averaged over the whole-body and spatial-peak SAR not exceeding 8W/kg averaged over 1 gram of tissue. For general population/uncontrolled environments, the MPE is 0.08W/kg averaged over the whole-body and spatial peak SAR not exceeding 1.6W/kg averaged over 1 gram of tissue. If you want to try this measurement at home, remember the gram of tissue has to be in the shape of a cube, according to new FCC rule 2.1093.

Fortunately, the rule does not require that you actually use a cube of tissue in making your measurements. The new rules accept computational models to demonstrate compliance. If you are as inept as 1 in carving the Thanksgiving turkey, this mathematical substitute is welcome!

## Compliance for mobile units

Most of the compliance burden with the new standards falls on equipment manufacturers. The most-affected manufacturers are those that produce mobile and portable equipment used near the body, such as cellular phones, personal communications services (PCS) mobile equipment and enhanced specialized mobile radio (ESMR) devices. Compliance with the new rules will be incorporated into the equipment authorization process.

Although the FCC does not require manufacturers to recall units or even to seek reauthorization of previously approved equipment, future authorizations will be tied to demonstrating compliance with the new standards. Therefore, two-way radio shops and carriers can assume that equipment they put on the street bearing FCC approval also complies with RF environmental concerns.

Even so, the FCC has created at least two categories of this equipment, high-

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- O The Micro RF Isolator (AF)
- O All of the above (AZ)

- 2. What do you usually test?
- O Two-way radios (JA) O Pagers (JE)
- O Trunked radios (JF) O Cell sites (JT)
- O Encrypted systems (JG) O Cell phones (JU)
- 3. When do you plan to buy test equipment?
- O In 1 month (HA) O 7-12 months (HC)
  O 2-6 months (HB) O More than a year (HD)
- 4. Do you buy test equipment in your company or does someone else? O I do (EA)

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powered and low-powered mobile units. Each, presumably, is subject to different compliance standards. Moreover, industrial equipment is presumably subject to a lower standard than personal communications devices. The FCC definition of industrial equipment is "push-to-talk" equipment. Two-way units in industrial settings theoretically are distinguishable from transmitters used by the general public. Common sense might differ with

this approach, but the FCC does not.

Because the FCC used part of its Order to describe testing and standards arising from the difference in exposure from devices that represent a radiation source typically operated more than 20cm from the body, the 20cm discussion will set a minimum standard for all future microphone cords. The FCC did logically note that most antennas for vehicle-mounted devices are outside the car, safely away

from the operator, and provided exemptions for these devices.

#### Compliance for fixed transmitters

The likely candidate for providing compliance with limitations for fixed transmitters appears to be either the operator or the site owner. The Order is somewhat vague about exactly who will be forced to demonstrate compliance in all instances, but because the showing of compliance is to be made in applications for station licenses, the most likely entity is the radio licensee.

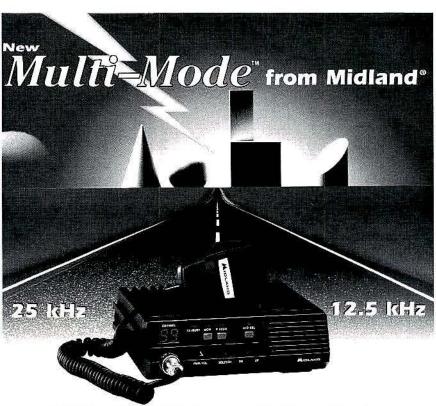
The rule of thumb adopted by the FCC in its Order is, simply put, if the transmitter is operating at greater than 1,000W at a height of less than 10m, the facility is subject to a demonstration of compliance with the new rules. Additionally, even if the facility is operated at a greater height above terrain, if it is operated in a manner that might expose the public to RF radiation (e.g., an unrestricted rooftop), the licensee or site owner might still have to demonstrate compliance regardless of height.

What is not clear in the Order is whether the 1,000W level is per channel or per site. The FCC's use of the words "station," "channel" and "facility" within the text of the Order was not wholly consistent, leaving this vital question open to future clarification. Despite that, I am willing to predict that many station licenses will be modified in the future to show effective radiated power (ERP) levels of 999W.

#### Transition period

The portion of the text of the Order having to do with the transition is vague, apparently intentionally so. On the one hand, the FCC states that equipment authorizations for devices submitted after Jan. 1, 1997, must meet the new standards and that all previously authorized devices shall be grandfathered. Then, the FCC states that it will, of course, reserve the right to investigate any otherwise grandfathered device if it believes there might be a problem.

As for station licensees, the FCC takes "vague" to the limit. The Order states that the new standards will be applied at the time of application and licensing. On the other hand, the Order also states that all licensees are expected to comply with the environmental rules, including existing licensees. My best guess would be that the FCC will incorporate its new rules immediately into the application process and that it is also suggesting that previously licensed facilities will be sampled for



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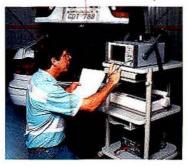
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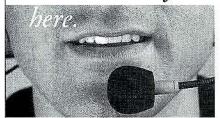
The one logical conclusion is that it is unlikely that licensees will be investigated prior to the publication of OST Bulletin No. 65, which is intended to outline the agency's recommended methods for testing and reporting RF exposure. The agency usually prefers a formula that it can apply in highly technical areas of compliance, and its Order, although setting forth standards, falls short of providing a formula for determining compliance.

#### Pre-emption

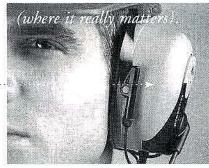
When this rulemaking proceeding began, local governmental agencies and the federal government were wrestling with the question of which one would determine RF exposure standards for local zoning legislation and decisions. In the Telecommunications Reform Act of 1996, Congress reserved the setting of standards to the FCC for all "personal wireless services," effectively pre-empting local law unless a substantial showing could be made by a local government to the FCC.

The definition of personal wireless services within the Act is quite broad and includes, in effect, all land mobile radio services. With this in mind, the agency's Order tracks the language of the Act. denying petitions from local governments that disagree with the FCC's assertion of jurisdiction in this area. Regardless, the

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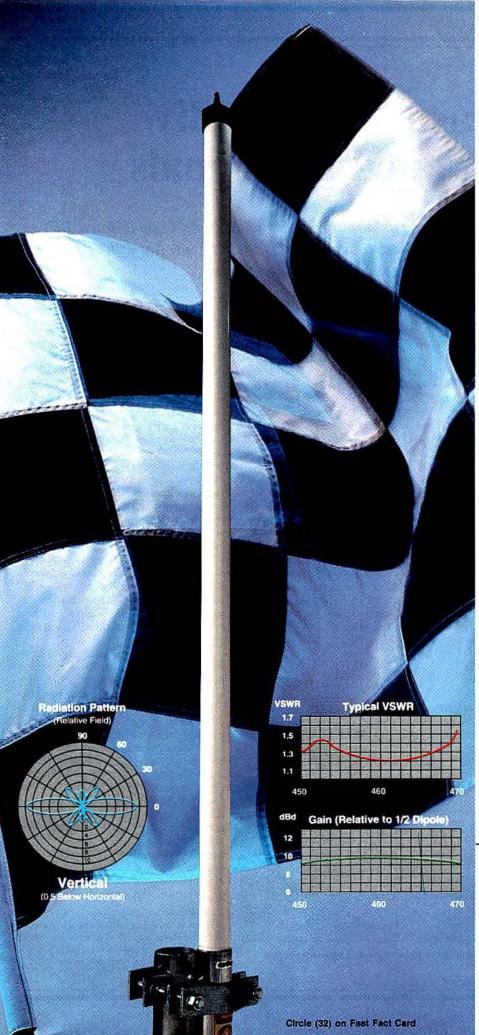
If a facility meets the FCC's RF environmental exposure standards, local governments cannot deny approval on the basis of public health. This preemption by Congress is being challenged, and the outcome could affect the definition of State's rights in such areas.

agency states that its pre-emption authority extends only to personal wireless services, leaving open the possibility that local zoning and public health authorities could assert themselves in non-pre-empted areas of telecommunications.

In sum, the language of the Act states that if a personal wireless service facility meets the RF environmental exposure standards created by the FCC, the local governments cannot deny approval on the basis of public health. This pre-emption by Congress is being challenged in court, and the outcome could affect the definition of State's rights in such areas.

First step

The FCC's Order is a first step toward recognizing the possible hazards of RF energy exposure. It does not state that, thus far, the alleged dangers are hardly quantifiable. It does not point out that typical persons are subject to RF exposure from a myriad of unregulated household devices, electrical wiring and brush motors, more often at levels that far exceed any that would come from a telecommunications device. Only experience will demonstrate the practicality of the FCC's new standards, which, as is typical, are "subject to future change."



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# Measuring digitally modulated RF signals

Part 1—Multipath reflections cause more problems with digitally modulated RF signals than with analog-modulated signals. In this installment, flat fading and frequency-selective fading are explained.

By James Bush, Ph.D., and Gary Schober

Digitally modulated radio-frequency (RF) signals manifest unique characteristics at personal communications services (PCS) frequencies when they are reflected. Reflections add out-of-phase data symbols that cause bit errors. Paradoxically, simple signal-strength measurements at PCS frequencies (using signals with a narrow bandwidth, such as a continuous wave [CW]) can be deceptive because, although the signal may even appear to be quite strong, when it is digitally modulated, the bit-error rate (BER) performance may be poor.

Multipath reflections (multipath, for short) of the RF carrier are better known as time dispersion or delay spreading. Time dispersion or delay spreading occurs when a single signal travels from its source to the receive antenna via two or more paths of different lengths. One part of the signal may come directly; the others have been reflected during their travel and take longer to reach the receive antenna. The effect is as though two or more individual signals with identical modulation reach the receive antenna, but with the modulation having been offset, or delayed, by various intervals of time.

Reception of a signal affected by time dispersion is deteriorated. Reflections must be considered when planning and optimizing digital radio systems that use high data rates.

Characterizing an RF channel's delay spread determines whether the energy on the radio channel is affected by flat fading or frequency-selective fading. Flat fading means that all frequency components transmitted through the channel bandwidth are affected by the same magnitude of fading. Conversely, frequencyselective fading, also known as differential fading, means that some parts of the channel bandwidth are affected by greater fading than other parts. If the channel is not flat, then a signal equalizer is required at the receiver to maximize the system performance for any given data rate and carrier frequency. Generally, a channel is considered flat when

$$\frac{Y}{T} < 0.1$$

where

Y = root mean square (RMS) delay spread

T = symbol period

Higher frequencies and digital wireless

 $\begin{array}{c|c} X(\omega) & y(\omega) \\ \hline \text{TRANSMITTER} & COMMUNICATIONS \\ \hline \text{CHANNEL } R(\omega) & \\ \hline \end{array}$ 

Figure 1. The communications channel is considered to be linear and time-independent with frequency response  $R(\omega)$ .

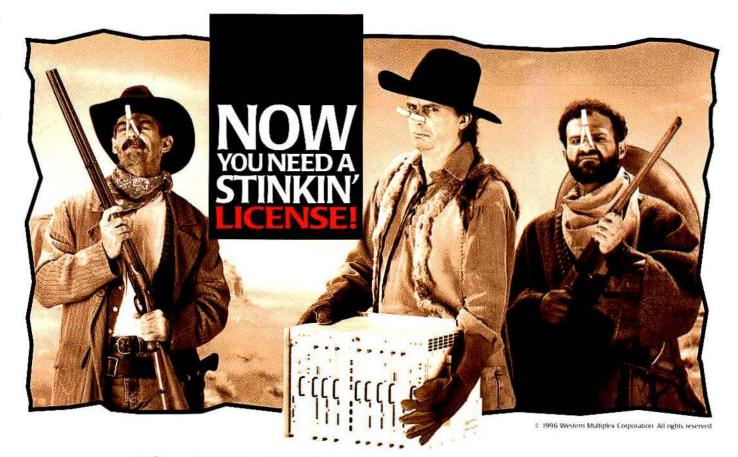
technology developments have made it necessary for RF engineers to broaden their knowledge of radio propagation. Today's designers are finding it necessary to better understand what causes compound signal distortion of digitally modulated RF signals and to keep current with propagation phenomena that affect them. Actual propagation measurements provide data from which time dispersion effects and path loss can be calculated. Decisions concerning antenna placement, base station location, antenna directionality, power remediation and channel reuse efficiency all are influenced by real-world measurements.

Time dispersion can be characterized by excess delay, mean excess delay and RMS delay spread. The path-loss exponent and standard deviation can characterize path loss with a simple statistical model in a log-normal shadowing environment.

To examine the effects of multipath on RF communications, the RF communications channel is considered as though it were another system element. For simplicity, the communications channel is considered to be linear and timeindependent with an impulse response r(t)and a frequency response  $R(\omega)$ . (See Figure 1 at the left.) An RF communications channel's properties vary over time, so it clearly is not time-independent; nevertheless, for the purpose of understanding multipath effects, it is convenient to ignore its time-dependence as an unnecessary complication and to consider small periods during which the channel's properties are stable.

Overlooking for the moment the effect of distortion and considering only the

Schober is president of Berkeley Varitronics Systems, Metuchen, NJ. The company makes the Duet sequential-correlating channelsounder, the sounder described in this article.



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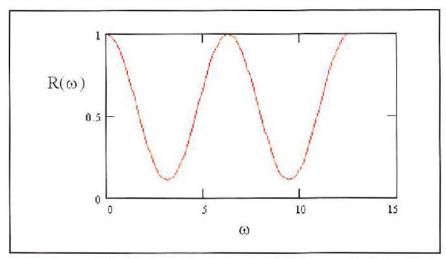


Figure 2. The magnitude of the channel frequency response in the presence of a single multipath.

effect of multipath, the signal at the receiver, y(t), is the sum of the delayed versions of the original transmitted signal, x(t). For example, with only two multipath signals:

$$y(t) = P_0 x(t - T_0) + P_1 x(t - T_1)$$

where  $T_0$  and  $T_1$  are the delays of each

path, and  $P_0$  and  $P_1$  are the corresponding received signal strengths. The sum could correspond to a direct path delayed  $T_0$  seconds and a reflection from a nearby building with a total path delay of  $T_1$  seconds.

Because the system (channel) is considered to be linear, the impulse response of the channel is enough to characterize it. In the example, [where  $\delta(t)$  is the delta

function, an impulse at the origin] the impulse response would be:

$$r(t) = P_0 \delta(t - T_0) + P_1 \delta(t - T_1)$$

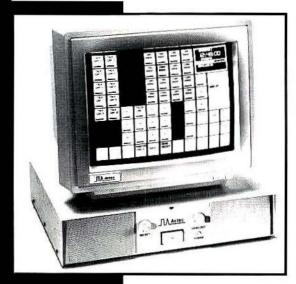
The absolute delay of the signal does not contain as much information as the difference between arrival times of the multipath components. This difference,  $\tau$ , determines the manner in which the transmitted signal is changed. In this simplified case, small values of  $\tau$  correspond to close-in multipaths in the general case, where all of the multipaths arriving at the receiver near the time of arrival of the strongest signal. Larger values of  $\tau$  correspond to channels that have a large delay spread.

Rewriting the impulse response and showing the frequency response of the simplified channel in terms of  $\tau$  yields the following mathematical result, which can be interpreted to understand much about the general case:

$$r(t) = P_0 \delta(t - T_0) + P_1 \delta(t - T_0 - \tau)$$

$$R(\omega) = P_0 e^{-t\omega T_0} \left( 1 + \frac{P_1}{P_0} e^{-t\omega \tau} \right)$$

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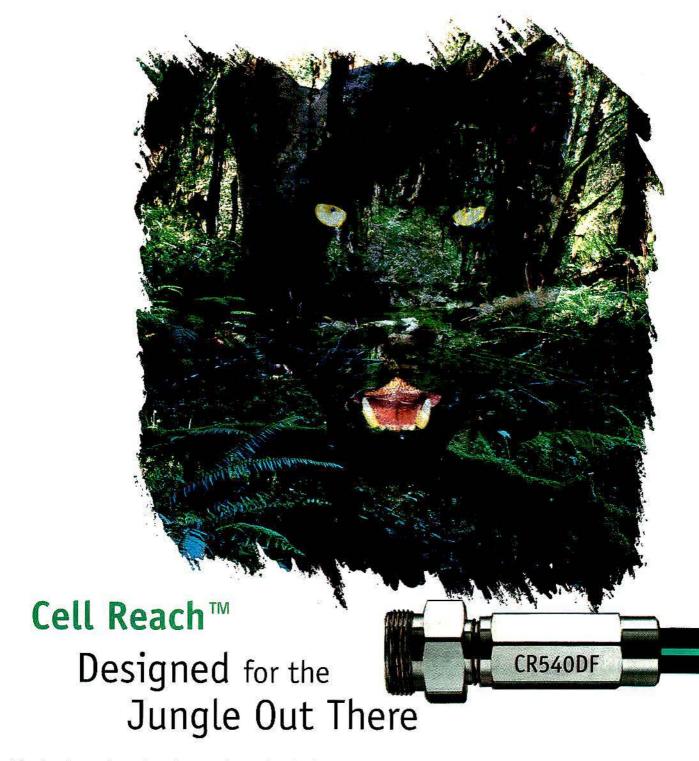
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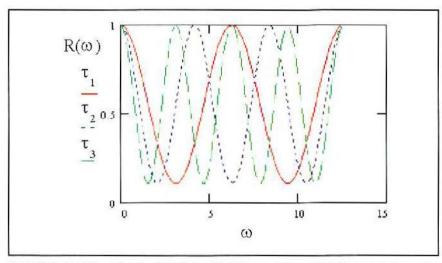


Figure 3. In a mobile environment, as the receiver is moved around, the difference between the two paths changes constantly, and the peaks in the channel's frequency response slide back and forth. The shifting frequency response causes the signal strength at the receiver to fade in and out.

 $|R(\omega)|^2 = P_0^2[(1 + S^2 + 2S\cos(\omega \tau))]$ 

where

$$S = \frac{P_1}{P_0}$$

Most important is the magnitude of the channel's frequency response. The frequency response is shown normalized in Figure 2 on page 42. The width of the power peaks depends on the value of τ. The smaller  $\tau$ , or in the general case, the delay spread, the larger the bandwidth of those peaks. The depth of the valleys is determined by S, the ratio of strength of the largest signal, which is referred to as the main signal, to the strength of the multipath component.

Referring to the equation, notice that this variation is periodic with period 7in fact, it is an offset cosine wave form. This variation means that, for large 7, there are many close-together peaks, and for small T, the peaks are farther away from each other.

The addition of a multipath component changes the communication channel from a loss-only device to a frequencyselective filter; therefore, the communications channel actually rejects certain frequencies. The addition of more multipath components will change the spectral response of the channel, although it will, in general, be some sort of frequency-selective filter.

If the signal strength of the multipath component is low, relative to the main signal, then the valleys are shallow and are not of much concern. When the multipath signal strength approaches that of the main signal, the valleys become deep, and they

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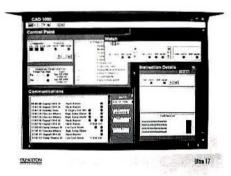
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can interfere with communication.

When the widths of the peaks in the channel's response are much larger than the bandwidth of the information on the channel, the frequency components of the entire received signal are attenuated by about the same amount. The amount of attenuation may be small if the information happens to be positioned on a peak, or severe if the information is in a valley. This type of attenuation is known as flat

fading. In a mobile environment, as the receiver is moved around, the difference between the two paths changes constantly. and the peaks in the channel's frequency response slide back and forth. (See Figure 3 on page 44.) The shifting frequency response causes the signal strength at the receiver to fade in and out.

If a channel does not exhibit flat fading, different frequency components of the signal are attenuated by different

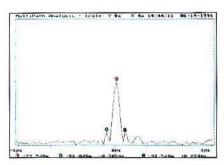


Figure 4. A signal with negligible multipath components.



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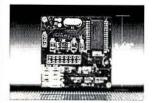
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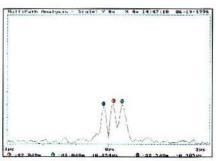


Figure 5. Multipath components are close-in, and are decaying with increasing delay.

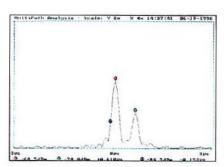


Figure 6. Severe intersymbol interference.

amounts. This type of signal strength variation is called frequency-selective fading. In an extreme case, ranges of the frequency spectrum of the information can be notched out, with disastrous results for the received signal.

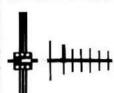
Communications channels, especially in the mobile environment, generally are sounded, or measured, with continuouswave (CW) transmitters and narrowband receivers. Unfortunately, the only multipath information that can be detected with this type of measurement is the presence of low signal strength at the carrier frequency, which could be caused by path loss or flat fading. CW measurements do not detect frequency-selective fading if the carrier frequency is not attenuated, which means that areas validated with CW measurement equipment may be unusable for communications.

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digital PCS equipment, these considerations become even more important. Many of the digital communications techniques, such as code-division multipleaccess (CDMA) and global system for mobile communications (GSM, formerly Groupe Speciale Mobile), use high data rates and, consequently, large bandwidths. The use of large bandwidths makes these systems particularly vulnerable to frequency-selective fading. Compounding the problem, the licensed PCS frequencies are near 2GHz. Signals in this frequency range exhibit a lot of multipath because many outdoor surfaces reflect energy at 2GHz.

Although these results are not new, until recently, no affordable commercial equipment could measure multipath information. With current equipment, multipath information can be gathered as easily as making CW measurements.

Figure 4 on page 46 shows a signal without multipath components. It shows a real-time display of multipath information. The horizontal axis shows the time of arrival of a signal. The vertical axis shows the power of the signal component arriving at that time. The small bumps near the main peak actually are the impulse response of the transmitter's output filters. These filters smear the data in time for the purpose of band-limiting the output spectrum.

Figure 5 on page 46 consists of a closein multipath and a multipath considerably farther away. The more distant multipath can cause valleys in the spectrum every 300kHz. The figure's scale is linear, so this multipath component is nearly the same amplitude as that of the main component. This image was captured in an area where a GSM system was having difficulty communicating with mobile units. The bandwidth of a GSM signal is 200kHz.

Figure 6 on page 46 shows three close signal components with nearly the same amplitude arriving at the receiver at different times. Such a condition would be likely to cause severe flat fading for low bandwidth systems and severe frequencyselective fading for higher bandwidth systems. Note that a CW measurement might show the signal strength to be the sum of all three signals.

Next: A sequential-correlating channelsounder optimizes 2GHz PCS systems to overcome the degenerative effects of multipath.



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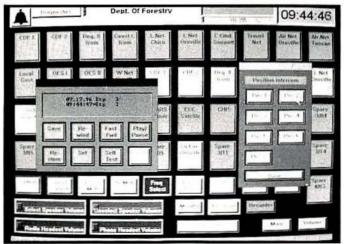
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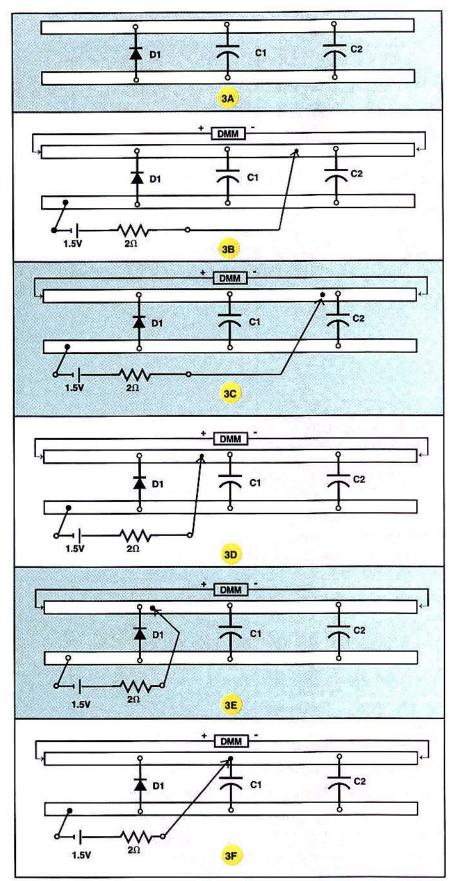
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#### Technically speaking



(continued from page 8)

probe connected to the RF/IF stage input side. Then, with the demod probe connected to the stage output, the RF signal level is reduced to maintain the same indication on the meter. The degree of reduction of the RF generator level is an indication of the stage gain. For example, if the RF generator level were reduced by 15dB to maintain the same reading on the voltmeter, then the stage gain would be about 15dB.

Figure 1 on page 8 shows the test setup using a SINAD meter. Figure 2 on page 8 shows the setup using an audio amplifier. A Radio Shack model 277-1008 is an excellent audio amplifier for this purpose.

#### Locating short circuits

Locating short circuits has always been a hassle. When there are several possible shunt paths to ground on a voltage rail, which path has the shorted component that is forming the short circuit? Often, it comes down to disconnecting components one at a time to observe the effect on the current drain. This is the hit-or-miss method! Such methodology is time-consuming and is not professional. Some technicians even resort to cutting circuit board foil to eliminate a possible suspect. (Yes, I confess. I've done it too!)

There is a method so precise that it will lead you right to the location of the short circuit on a circuit board. Sound too good to be true? It is simple, it works, and the necessary equipment is found in practically every radio shop.

Figure 3A at the left represents a circuit board voltage rail and ground with

Figure 3. At A, three components are connected between two strips on a circuit board. The top trace is the supply voltage rail, and the bottom trace is the ground. If one of these components is shorted, then all three are suspect, because they are connected in parallel. If C1 is shorted, this series shows how to locate the short. At B, a dc current is forced through the circuit as shown. With the probe connected as shown, the DMM voltmeter reading will be a negative value. This indicates that the power supply is connected on the negative side of the short circuit, as referenced to the DMM terminals. At C, the DMM will indicate a more negative value, because the power supply probe is connected farther from the short toward the negative terminal of the DMM. At D, the power supply is connected on the opposite side of C1, so the DMM indicates a positive value, indicating that the probe is connected on the positive side of the short, as referenced to the DMM terminals. At E, the DMM indicates a more positive value because the power supply probe is connected farther from the short and closer to the positive terminal of the DMM. At F, the DMM will indicate "000" volts, because the power supply probe is connected directly at the short circuit.

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#### Technically speaking

two capacitors and a diode connected between the voltage rail and ground. One of the components is shorted, but which one? Each component could be disconnected one at a time to observe the effect on current drain, but suppose they are very difficult to gain access to-what then?

Since printed circuit foils possess a certain amount of resistance (depending on thickness, width and length) a small amount of voltage drop will appear across the foil when current flows through it. That is the basis for the following procedure.

A digital voltmeter is connected across the ends of the voltage rail as shown in Figure 3B on page 50. Then a battery is connected, as shown, with a  $2\Omega$  resistor connected in series. The resistor serves to limit current flow through the circuit foil in order to protect the foil from overheating and burning. At the same time, enough current is allowed to flow so that a measurable voltage drop is produced. At Figure 3B, let's suppose that capacitor C1 is shorted. With the resistor connected at the point shown, the dc voltmeter will indicate a negative reading.

That means the probe has been placed on the negative side of the short as referenced to the voltmeter terminals.

If the probe is moved farther to the right as shown in Figure 3C on page 50, then the voltmeter will indicate a more negative value, indicating that the probe is father removed from the short circuit in the direction of the negative voltmeter terminal.

If the probe is repositioned as shown in Figure 3D on page 50, then the voltmeter will indicate a positive reading, meaning that the probe has been placed on the positive side of the short as referenced to the voltmeter terminals. If the probe is moved farther to the left (Figure 3E on page 50), then the voltmeter will indicate a more positive value, indicating that the probe is farther removed from the short circuit in the direction of the positive voltmeter

To locate the short circuit, the probe is moved along the rail until the voltmeter reads "000." This is the pinpoint location of the short circuit, and the component connected to this point is the culprit.

Instead of using the battery with the

current-limiting resistor, a constant-current power supply could have been used. Be sure to limit the current to the minimum amount that provides a usable reading on the voltmeter. In some cases, the current may have to be increased to produce a sufficient voltage drop for this method to work. Just be sure to limit the amount of time the probe is connected to prevent burning the circuit trace.

Another useful tool for locating short circuits is the "Shortsqueek" from Global Specialties. It emits an audible tone, and as the probe is moved closer to the location of the short circuit, the tone increases in frequency. By listening to the tone frequency you can locate the source of the short circuit.

Whether you are troubleshooting down to the component or to the board, don't be afraid to try new troubleshooting techniques. Some techniques are more efficient than others, so try to use the technique and equipment that fits the situation. Learn to adapt.

Next time, we will conclude this miniseries on troubleshooting.

So, until next time-stay tuned!



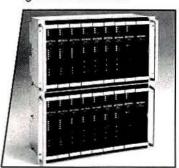
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### FCC tower regulation guidelines

Here come the deadlines! Owners of antenna structures and FCC licensees need to respond to new registration procedures for new, existing or altered towers. Ten states must be registered by the end of October 1996; all U.S. states and territories must be registered by June 1998.

#### By D.A. Keckler

Owners of antenna towers that are taller than 200 feet above ground level, or that may intersect the flight pathways of a nearby airport, must register the structure with the FCC and have the structure's placement studied by the Federal Aviation Adminstration (FAA).

Previously, antenna registration was incumbent on the antenna site *licensee*, whether that entity was an owner or a renter, but now it is the *owner* of the real property who is accountable. This is a result of the FCC's *Report and Order* in WT Docket No. 95-5 adopted in November 1995, which was intended to streamline the antenna structure clearance process.

Although the FCC has scheduled a twoyear program for completing registration in all U.S. states and territories, antenna structure owners have to hit the assigned deadline for their specific state, as shown in the table at the right. This includes 10 states for which the deadline is this month.

After the owner registers the antenna structure, the FCC will issue the owner a seven-digit registration number unique to that structure. Each tenant licensee and permitee on the tower must be provided with a copy of that registration, which must be referenced by the licensee in subsequent filings with the FCC.

In its Report and Order, the FCC noted that owners of existing structures may need to correct site information when they register. However, the Federal Aviation Administration (FAA) requires a new aeronautical study for corrections in latitude or longitude of one second or more, or height corrections exceeding one foot. Those owners need to make immediate notification to the FAA.

Copies of fact sheets and registration forms (FCC Form 854) are available from the FCC by calling 800-418-3676.

FILING WINDOW	STATES AND TERRITORIES
July 1-October 31, 1996	Alaska, Arizona, Hawaii, Massachusetts Michigan, Missouri, Montana, New Mexico, New York and North Carolina
November 1-November 30, 1996	Illinois and Wyoming
December 1-December 31, 1996	Nevada, Oklahoma and Puerto Rico
January 1-February 28, 1997	California and Ohio
March 1-March 31, 1997	lowa and Virginia
April 1–April 30, 1997	American Samoa, Georgia, Guam, Gulf of Mexico, Midway Island, Northern Mariana Islands, U.S. Virgin Islands and Wake Island
May 1-May 31, 1997	Louisiana, Maine and Rhode Island
June 1-June 30, 1997	Colorado and Minnesota
July 1-July 31, 1997	Nebraska and Pennsylvania
August 1-September 30, 1997	Florida and Indiana
October 1-October 31, 1997	Delaware, Kansas and Washington
November 1-November 30, 1997	New Hampshire, Oregon, Wisconsin and West Virginia
December 1-December 31, 1997	Alabama, District of Columbia and Maryland
January 1-January 31, 1998	Arkansas, North Dakota and Utah
February 1-February 28, 1998	Idaho, Mississippi, South Dakota and Vermont
March 1-March 31, 1998	Kentucky and Tennessee
April 1-April 30, 1998	Connecticut, New Jersey and South Carolina
May 1-June 30, 1998	Texas

Source: Federal Communications Commission, Compliance & Information Bureau.



#### egulating technology

#### What's in a name?

By Robert H. Schwaninger Jr.

At least a dozen times a day, some operator in this country is asked to reveal his most prized information: his customer list. Maybe he's being approached to sell his business, or maybe a distributor is requiring the list as a portion of a distribution contract, or maybe the FCC is asking to verify loading. Whatever the reason this most sensitive of information is being requested, it is often without protection or justification.

The most common of these demands occurs within the reseller agreement. Within the terms of reseller agreements, it's not unusual to have the carrier demand the names of each reseller customer. The terms of the agreement state (without the legal jargon) that if the reseller doesn't make regular payments, the reseller's customers become the carrier's customers. Put

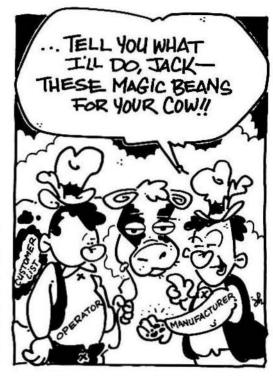
Schwaninger. MRT's regulatory consultant, is a partner in the law firm of Brown and Schwaninger. Washington, DC. He is a member of the Radio Club of America.

another way, "Either you pay, or I own your business,"

If the fundamental unfairness of these contract terms is not immediately obvious, consider the outcry there would be if a local telephone tariff had language that allowed the telephone company to take over the business of any common carrier that didn't pay line charges. I strongly doubt that such terms are a portion of Arch Communications' contracts with the regional Bell companies. Yet, large paging companies often put those terms in reseller agreements.

Such onerous tactics have existed for years and, unfortunately, the use of these tactics is increasing. Carriers and manufacturers are finding new ways to gain such customer information and a peek into the books of their independent distributors. The question is, why? The reasons are obvious and disturbing.

Cellular companies and paging companies often have their stock prices tied to customer numbers and cash flow projec-



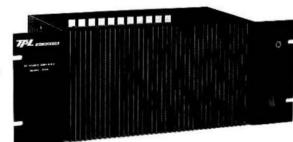
tions. If their resellers' customer base is the property of the reseller and not the carrier, eventually the value of the carrier

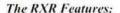
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is held, in some part, by the resellers and not the carriers. This shift of ownership power is quite disturbing for many carriers who seek to control their customer and cash flow numbers to prop up stock prices.

Additional reasons may be evident if you consider customers as collateral. Although that may be a dehumanizing perspective, that's business. After you've reduced your customers to ciphers, consider what each customer contract is worth. After a little head scratching, you will soon discover that the tactics of using customer contracts for collateral is extremely one-sided. Although a reseller might get in arrears with the carrier, it is unlikely that the arrears would ever come close to the value of the cus-

Vague references to customer satisfaction, given as justification for demanding sensitive customer information, are without logical support.

tomer contracts. Therefore, the practice of using customer contracts as collateral against payments for service (which usually are paid in advance, anyway) is grossly unfair to resellers and provides greater than 100% security for the carriers.

For a simple comparison, consider that the bank only expects your house to be worth 20% more than the mortgage, whereas, customer contracts might easily be worth 500% more than the reseller's debt to the carrier.

The fundamental question is, then, whose customers are these? The reseller would claim the customers because it went out and made each sale. The carrier would say that the customers belong to it, because it provides the basic service. This ongoing contractual debate can be solved by focusing on the transaction and assigning duties to protect each party's true interest. For example, the reseller might be required to pay greater deposits, thereby continuously protecting the carrier. This simple solution appears far more equitable and would mirror the carrier's deal with the telephone company. After all, shouldn't all portions of the distribution chain have equal benefits and risk?

#### Manufacturers' machinations

Although carriers can find some justification for demanding customer names, manufacturers' efforts to find a similar justification are laughably weak. In an amendment to a distribution contract produced by Motorola's Radius division, the language states that the furnishing of customer lists to Motorola by distributors is necessary to maintain the integrity of the distribution chain and to serve customers' interests. Huh?

These types of vague references to customer satisfaction, given as justification for demanding sensitive customer information, are without logical support. Are we to believe that Joe's Towing Service is better served if Motorola knows that Joe bought Motorola's products? How? Joe doesn't care whether someone in Schaumburg, IL, has his name. In fact, Joe might not want his name to rise up the Motorola food chain.

In addition, the same agreement allows for Motorola to audit the books of the distributor. Again, why? The distributor's



#### Regulating technology

books are of no concern to manufacturers for any legitimate purpose, unless the manufacturer is providing substantial financing to the distributor. Even then, this is a questionable tactic. The same distributor might be selling E.F. Johnson, Standard, Kenwood and Midian products. Should one manufacturer be allowed to compare sales of products through such an audit?

When manufacturers demand this kind

of intrusion into a distributor's books and records, the reasons given are invariably weak and vague. The motivation often lacks any legitimate business purpose. It often is simply high-handed tactics of market power focusing on an avenue for greater market data.

#### Get protection

Although every carrier, manufacturer

and distributor will claim that the terms of its agreement are "standard," there is no such thing as a non-negotiable agreement. Each is subject to discussion and change. Here are some simple tips for protecting your customer information.

First, if the carrier or manufacturer insists on the information, only allow the information to be provided under a non-disclosure, non-circumvention agreement. That is, you will give the information, but the entity receiving the information cannot use it or disclose it in any fashion, especially to raid your customer base to sell your customers alternative products or to compete with you.

Second, if a carrier wants to "own" your reseller customers, find another carrier. Although everyone should pay their bills faithfully to their suppliers, those suppliers should not be in a position to take over the business the minute you miss your "minimum payment due." However, be prepared to offer greater security deposits and advanced payments to decrease the level of risk borne by suppliers.

Third, if you are getting financing for equipment, you should offer your books for audit by the financing manufacturer, but only under two conditions: prior to securing the initial loan and any time that an increase in the loan or line of credit is requested. If you are making prompt payments against the loan, the manufacturer should accept the payments as all necessary evidence of good faith and responsible business practices, without further investigation. (Beware of lease and buy-out arrangements that provide a basis for demanding information about the location of the "leased" equipment, if the leased equipment will be held by customers.)

Fourth, if the FCC requests customer information, demand that the information be protected from disclosure to competitors seeking such data by employing the Freedom of Information Act. The FCC rules will accommodate this request, and it is reasonable to request such privacy protection.

Finally, if you are already subject to one of these contracts, take gradual steps to get out from under the terms, such as offloading your customers onto another carrier's system that offers more equitable terms, or preparing for renegotiation of the most onerous terms upon renewal of your present contract. If you don't, you will one day discover that your business is little more than sharecropping, with all purchases being made at the company store, and that you actually own little for your labors.



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#### Support for pACT effects formation of industry organization

Strong support for a new two-way paging and messaging protocol, personal Air Communications Technology (pACT), has led to the formation of a new industry organization, the pACT Vendor Forum. To date, 24 companies from around the world have joined the Forum, including AirLink Communications, AT&T Wireless Services, Casio, CNet, Ericsson, LanSer Telecom, NEC, NovAtel Communications, Panasonic, PCSI, Rogers Cantel Paging and Sierra Wireless.

Developed by a collaboration of companies experienced in the design of wireless data and cellular digital packet data (CDPD) systems, pACT is the first Internet Protocol (IP)-based, open standard in the narrowband PCS (N-PCS) industry. The pACT Vendor Forum is a not-for-profit association with a charter to "enable, support and promote the adoption of the pACT two-way N-PCS standard worldwide."

Members are dedicated to the rapid deployment of a variety of pACT products and services designed on an open systems basis, ensuring multi-vendor compatibility and interoperability. Membership is open to all vendors or prospective vendors of products or services that comply with the pACT standard. pACT Vendor Forum leadership includes board members from Ericsson, LanSer, NEC, PCSI and Retix.

#### MTA-EMCI projects more than 60 million pagers in service by 2000

In 1995, subscribers increased 31% to 34.5 million users, according to MTA-EMCI, Washington, DC, in its annual *State of the U.S. Paging Industry*. In 1995 the industry grew by more than eight million net subscribers, and that growth was driven by consumers, as opposed to business users. Among respondents to MTA-EMCI's survey, new subscribers used their pagers 65% of the time for personal reasons, and subscribers of three or more years only used their pager 29.8% of the time for personal reasons.

As a result of increased demand for a higher level of service, lower airtime prices and added system capacity, the share of alphanumeric pagers in service increased from 7% in 1994 to 10% in 1995, according to the survey.

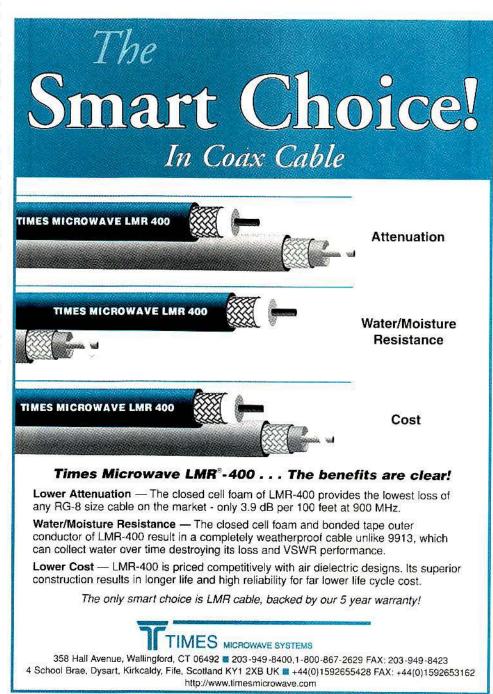
The increased growth of paging also prompted several mergers and acquisitions in 1995. As the industry consolidated, carriers with a total of 2.9 million subscribers were acquired by or merged with other paging carriers. In 1995 the top 12 paging carriers held 65% of all subscribers; those same companies held 45% in 1994.

#### Glenayre, CNET plan merger

Glenayre Technologies, Charlotte, NC, and CNet, Dallas, have signed a merger agreement. There will be a tax-free exchange of new shares of Glenayre Common Stock to CNet's shareholders and optionholders. The transaction will be accounted for as a pooling of interests and is expected to close in the fourth quarter of 1996. Certain shareholders, who in the aggregate own more than 50% of CNet's

shares, have granted Glenayre a separate option to purchase their shares if specific events occur that result in the termination of the merger.

Following the transaction, CNet share-holders and optionholders will own less than 1% of Glenayre on a fully-diluted basis. CNet will operate as the CNet Division of Glenayre and will continue to market its products under its brand name and trademarks.



#### News

#### Motorola launches disaster recovery service for two-way radio users

Motorola's Americas Service Division (ASD) has launched its first disaster recovery service for those who operate twoway radio systems. The service addresses a broad range of potential disaster situations-from lightning, flooding and tornados to power surges, sewer backups, water damage, fire or even vandalism-that may compromise a two-way radio system's performance, or shut it down altogether.

Motorola offers the service as an extension of customers' existing service agreements on their fixed equipment. Each customer's plan is unique to them. Motorola conducts an extensive analysis to determine what equipment, personnel and logistics would be required to get the customer back on the air. The information is stored in a database for quick retrieval if necessary.

Celwave offers education program

Celwave, Marlboro, NJ, is offering an

educational program for cellular, PCS and

other wireless operators. The program,

dubbed "Celwave University," consists of

five day-long modules conducted by certi-

fied electrical engineers. Students can

choose any or all of the courses, and

classes can be conducted at the operators'

workplaces or at Celwave's headquarters.

The modules are Antenna Basics, Advanced Theory, Tower Top Amplifiers, Bidirectional Amplifiers and Filters & Combiners. Each is structured to impart basic

concepts and applications.

Combined land-based, satellite wireless data benefits truckers Since the Pro2000SL multi-mode communications system was introduced in 1995 by Rockwell International, Newport Beach, CA, and ARDIS, Lincolnshire, IL, more than 8,200 units have been ordered by truckload carriers around the country. By integrating ARDIS' extensive national coverage in metropolitan areas with the satellite links from Rockwell, trucking companies have experienced increased profitability and driver security and improved customer service. The combination of land-based and satellite communica-

tions provides truckload carriers complete

coverage virtually anywhere in the United

States, allowing a customer to roam from

a rural area in Utah to a covered loading

Two-way dealers, servicers benefit

from web site production services Bobby G. Thompson & Associates and Internet Direct have formed a strategic

partnership that will result in specialized web site production services for land mobile radio dealers and servicers worldwide.

Both Phoenix-based companies will work together to promote Internet Direct's

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for dealers who seek a professional World Wide Web presence without the expense

of dedicated hardware and technical staff

mobile radio dealers and servicers will be able to market their products and services,

provide better customer service and im-

prove employee communications," said Bobby G. Thompson, president of Bobby

G. Thompson and Associates. Dealers and

servicers have the opportunity to register a domain name for their Web site. A simple name, such as www.(company name).com is easy to remember and pro-

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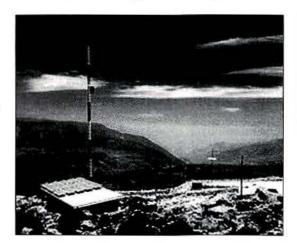
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#### Mobile Radio Technology

#### October 1996

#### DFW Communications buys Motorola company-owned service centers

Taking advantage of a 1995 Motorola National Service Division restructuring. DFW Communications purchased Motorola's four Dallas-Fort Worth two-way radio company-owned service centers in March 1996. The transition is a result of the restructuring of Motorola's service division, which implemented a new service strategy and consolidated all product repair services from company-owned service centers to one major high-technology Radio Support Center subscriber depot in Rockford, IL. The transition to an independent full-line product dealer-servicer increased DFW's staff from 29 to 42 employees. The company plans to offer new products and services, including two-way paging products and rental services. An Internet World Wide Web site is also being designed.

#### Batteries Batteries Inc. acquires Battery Networks, Alexander Battery

Batteries Batteries Inc. (BBI), New York, has entered into an agreement in principle to acquire Battery Network, Alexander Battery and their affiliated companies. The acquisition is subject to the execution of a formal agreement that will provide for a purchase price in excess of \$14,000,000 and is payable in a combination of cash, convertible preferred stock and common shares of BBI.

Alexander, Mason City, IA, founded more than 30 years ago, is a national battery distributor and value-added assembler. The company's major battery product lines serve the laptop computer market

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under the brand names Battery Network and Absolute, the medical battery segment and the two-way radio segment.

BBI operates through three subsidiaries: Tauber Electronics, San Diego, is principally a value-added resource that designs and assembles battery packs; Advanced Fox Cellular, Philadelphia, distributes more than 1,500 cellular products, accessories and components through its business-to-business telemarketing and catalog circulation program; and Batteries Batteries for Everything, Phoenix, sells batteries and battery-related products, cellular products, accessories and components,

#### Railway company chooses Western Multiplex digital microwave radios

Western Multiplex, Belmont, CA, a wholly owned subsidiary of Glenayre Technologies, Charlotte, NC, has sold \$2.7 million worth of WM-4T-6 licensed digital microwave radios to Norfolk Southern Railway Company, Atlanta, Norfolk Southern will be using the WM-4T-6 in the areas east of the Mississippi River to replace its existing analog spur radios operating at 6GHz for intracompany networking. The radios were chosen because of their high performace, low power consumption, flexibility and small rack size, a company spokesman said. Installation is expected to begin in the fourth quarter of

Sabre's new plant will triple antenna production capacity

Sabre Communications, Sioux City, IA, is building a new plant on a 10-acre plot south of Sioux City that will triple the company's tower production capability. Administration, engineering and marketing offices will also be housed in the new facility. Construction is expected to be completed by October 1996.

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- \* FCC type acceptance pending (available for international sale)



#### Readers' choice

Of all the new products and services in the March 1996 issue, the one reprinted here generated the most reader requests for additional information. If you missed it the first time, here is your opportunity to acquire more information on it. Just circle the corresponding Fast Fact Card number on the card found in the back of this issue and mail the card to us.

#### NMO antenna simultaneously transmits on three bands

NCG/Comet Antenna's FX-555NMO antenna allows simultaneous transmission on VHF, UHF and cellular frequencies. The antenna screws into a standard NMO mount. For simultaneous TX/RX on any of the three bands, a triplexer is available. The coax from the antenna is screwed into the triplexer, and three radio connections are on the opposite side of the triplexer. The 27-inch-tall antenna has the appearance of an elevated-feed cellular antenna.

Circle (500) on Fast Fact Card

#### Analyzer measures coaxial line SWR, loss, RF power



Cable Mate from Anritsu Wiltron measures SWR, return loss, cableinsertion loss, RF power (watt meter) and distance-tofault on coaxial transmission lines. The analyzer covers a range from 5MHz to 1,200MHz. The unit uses fre-

quency domain reflectometry (FDR) to isolate transmission faults. Because FDR uses RF frequencies instead of dc pulses, the unit can locate RF faults, not just de open- or short-circuit conditions. The analyzer is lightweight and battery-powered for field use.

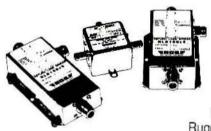
Circle (401) on Fast Fact Card

#### Base antenna redesign permits channel combination

Celwave has redesigned its PD201 Stationmaster base station antenna with a double bandwidth of 20MHz. The expanded bandwidth of the Stationmaster II permits several channels to be combined. Models cover the UHF range from 406MHz to 512MHz.

Circle (402) on Fast Fact Card

#### **VSWR BRIDGES & TEST CABLES**



#### **FEATURES:**

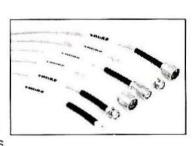
5 watt power High directivity RF reflected port Rugged construction

Using the EAGLE return loss bridge allows frequency domain reflectometry tests to be made easily and inexpensively. There is no need to spend thousands of dollars on a dedicated antenna tester. Simply use the EAGLE bridge with your present spectrum analyzer and tracking generator. This technique is described in our free application note. See offer below.

Price: \$389.00 for a 1.0 GHz bridge.

#### FEATURES:

Low loss Low Cost Custom labels Swept to 3.0 GHz Rugged! 60 lb. pull Excellent return loss



Are you frustrated with cable assemblies that break easily, are lossy at low microwave, or work intermittantly? Our bridge customers had the same problem. At EAGLE we now manufacture low-cost rugged test cables! Each one is tested on a vector network analyzer to 3.0 GHz. Our custom labeling makes cable ID a snap. Excellent return loss reduces disturbances to combiners and filters.

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Call for FREE application note: "Antenna and Feedline Measurements"



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#### Enhancements to service monitor include faster microprocessor, graphics



IFR Systems' enhanced version of its COM-120B communications service monitor adds more than a dozen innovations. The new version of the COM-120B includes a faster microprocessor and improved graphics for greater flexibilty in setting up custom test screens. PCMCIA port enhancements add user-definable test procedures and file storage and retrieval capabilities. The unit has an independent tracking generator, giving it the ability to independently sweep two sets of frequencies simultaneously.

Circle (403) on Fast Fact Card

#### Low-profile dc power supply integrates with base station installation

The TL series dc power supplies from Tripp Lite are designed to match most two-way radios on the market and to work as an intregrated base station installation. The series includes two 11A models, which feature a metal enclosure designed to house and protect the radio. The TL series combines all the standard features of Tripp Lite's PR series dc supplies, including voltage regulation, automatic overcurrent protection and full line isola-



tion. Continuous duty performance stands up to extended periods of operation.

Circle (404) on Fast Fact Card

#### Portable signal strength meter covers several wireless frequencies



The Champ Ultra-Lite from Berkeley Varitronics Systems is a hand-held, 9V battery-powered signal strength meter weighing slightly more than I pound. Users can select from standard models cov-

ering a wide range of frequencies: PCS, paging, IVDS, LMR, ISM and fixed wireless. The unit is also designed to find indoor RF "shadows" in wireless systems. In mobile studies, the meter can be used to detect RF leakage and to verify propagation coverage. Features include a wide dynamic range, temperature-controlled quartz accuracy, long running time, an eight-bit AD and a 2-line by 16-character LCD. IF bandwidths are available as an option.

Circle (405) on Fast Fact Card

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#### EEPROMs Provide Trunking Conversion for Mobiles

IDA Corporation of Fargo, ND announces the availability of LTR trunking conversion EEPROMs for various Motorola and Motorola Radius mobile radios. The replacement EEPROMs are available for popular models in the 400 MHz, 800MHz and 900MHz bands. LTR conversion of Privacy Plus mobile phones is also being offered. An inexpensive programming kit is required



to program the converted mobiles. Post-conversion features include group scan, TX time-out timer, trunked or conventional operation, CTCSS and

CDCSS, block decode and automatic channel acquisition.

#### IDA CORPORATION

1345 MAIN AVE. FARGO , ND 58103-1631 800-627-4432 • FAX: 218-233-1886 E-MAIL: ida1995@aol.com

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Circle (66) on Fast Fact Card

#### New products

#### UHF repeater groups logic, receiver, power elements into a single unit

The model 2004 UHF repeater from **E.F. Johnson** is for LTR trunking systems. The repeater delivers 100W of RF output, variable to 25W, and is available

#### Triple-bonded cable eliminates water migration, provides stability



A line of high-performance, low-loss,  $50\Omega$  coaxial cables, Cell Reach, from CommScope are designed for wireless transmission systems. The cables combine a smooth-wall copper outer conductor and

a high-strength, closed, microcell-foam dielectric. The cable is triple-bonded (center conductor to foam dielectric, dielectric to outer conductor and outer conductor to jacket), which provides electrical and mechanical stability, low VSWR and climinates water migration.

Circle (407) on Fast Fact Card

for 12.5kHz or 25kHz bandwidths. The unit combines logic, receiver, exciter and power amplifier into a single unit requiring only 9" in a standard 19" rack. A complete five-channel LTR repeater site, including combiner, can fit into a single seven-foot rack. The repeater is fully synthesized for easy frequency changes, with remote diagnostics and alarms, RF amplifier protection and PC programming capability.

Circle (406) on Fast Fact Card

#### Software routines speed RF propagation analysis

RFCAD 2.0 from Communications Data Services is PC-based propagation software for Microsoft Windows. Features include rasterized maps, site designation, data importation and output to various peripheral devices. Utility applications include reference point calculations, distance and bearing, coordinate conversion, HAAT and antenna pattern displays, both numerical and graphical.

Circle (408) on Fast Fact Card

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#### Package upgrades manual combiners with automatic tuning capabilities



Decibel Products Division of Allen Telecom Group has developed the fivechannel AutoCELL-UPG to allow cellular carriers to upgrade existing manual-tune combiners into autotune combiners. Upgrading the manual-tune combiners allows improvements in base station performance without replacing major components in the base station site or equipment racks. The AutoCell-UPG combiners provide status LEDs for alarms. The package also allows base stations to modulate analog and digital transmission isolation for each cavity.

Circle (409) on Fast Fact Card

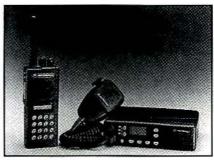
#### Generators provide as much as 8kW from small-footprint system

The Auxiliary Power System series of standby generators from Generac includes utility voltage monitoring, automatic start-stop, engine safety shutdowns and system battery charging. Options consist of ac or dc voltage outputs, telemetry monitoring, automatic transfer switch and weather-protected outdoor enclosures. Rated from 3kW to 8kW, the generators are available in natural gasor LP-fueled models. The three largest models have a 25" × 19" footprint.



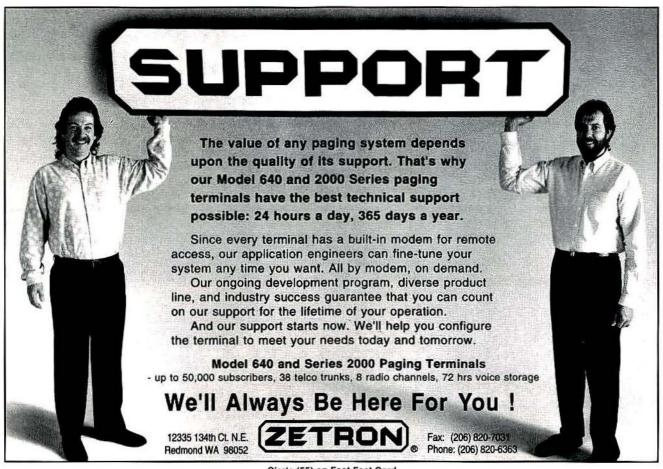
Circle (410) on Fast Fact Card

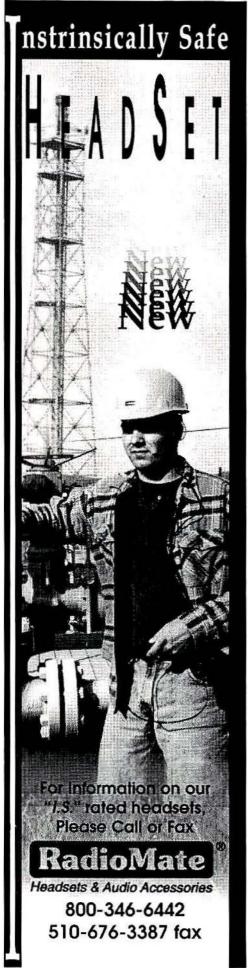
#### Two-way radios offer alternatives in trunking protocol, spectrum



The GTX series of mobile and portable trunked two-way radios from Motorola Land Mobile Products Sector are available in both 800MHz and 900MHz spectrum models, in Motorola Privacy Plus or E.F. Johnson LTR trunking protocols. Both models contain numeric display. Features include scan, talkaround, private conversation, telephone interconnect and call alert. Dual-mode capability supplies communication flexibility. Users have the convenience of selecting trunked or conventional repeater operation with 10 systems, eight talk groups and 10 conventional modes.

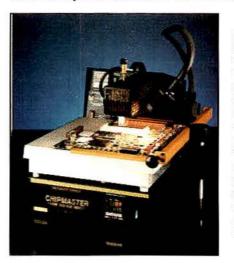
Circle (411) on Fast Fact Card





#### New products

Low-heat system minimizes thermal stress in circuit assembly reworking



The Radiant Chipmaster from Automated Production Equipment (A.P.E.-South) addresses problems faced when the reworking of large circuit boards, with irregular component and connect distribution, may lead to stress and thermal warping. The system's 12" × 12" mass radiant hot plate has temperature controls accurate to 2°F over 10 hours at pre-heat temperatures of less than 300°F. The high-power and low-heat feature of the system, when used with the Radiant package, allows reworking of large ceramic or sensitive high-density perimeter OMPACs with central thermal transmission ball contacts at temperatures less than 450°F, with a bottom heat of 150°F.

Circle (412) on Fast Fact Card

#### Controller maximizes throughput with Flex-POCSAG mode change

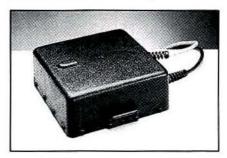
Glenayre's GL-C2000 paging controller is now capable of on-the-fly (OTF) mode change between Flex and POCSAG paging protocols, allowing carriers to maximize throughput when supporting both types of subscribers. The OTF feature enables transmitters to switch seamlessly between the deviation settings and frequency offset parameters required by the two protocols. The system is also



designed to improve performance when ReFlex and one-way protocols are mixed on a single RF channel.

Circle (413) on Fast Fact Card

#### Mobile direction-finding antenna works for paging, cellular systems



Model MA800 direction-finding (DF) antenna works for land mobile and airborne operations. The antenna from Cubic Communications is effective for cellular telephone and paging systems, but is especially suited for cartop or aircraft installation. It consumes little power during operation because of its signal-handling capability.

Circle (414) on Fast Facts Card



#### Glass-mount, 10W, cellular antenna provides 1.9:1 VSWR for cellular



Glaslink window-mount antenna from Antenna Specialists Division of Allen Telecom Group adheres with highbond, double-sided tape to vehicle windshields or windows. The tape attachment precludes drilling holes into the vehicle body during installation. RF signal loss is reduced by a hardwire connection between the coupling box and the feeder. Its cable is con-

nected to the cellular phone's transceiver unit. The antenna spans the entire cellular range at a typical 1.9:1 VSWR. The 14-inch antenna is rated at 10W of output power and a gain of 3dB.

Circle (415) on Fast Fact Card

#### Foam dielectric cable for RG-142 connectors provides lower attenuation

LMR-195-PVC cable from Times Microwave Systems is designed to accept standard RG-142 connectors with lower attenuation, better flexibility and lower cost than RG-142. Constructed with a foam polyethylene dielectric and a bonded tapeand-braid outer conductor, the cable has a loss of 10.7dB/100 feet at 900MHz and 16.1dB/100 feet at 2GHz. A PVC jacket lends flexibility and simplifies stripping.

Circle (416) on Fast Fact Card



#### Hand-held features 3W of power in three-button, keypad 900MHz models

The 900MHz model Avenger SI handheld radio from E.F. Johnson delivers 3W of RF power and is available in threebutton and DTMF keypad models. It can be programmed for as many as 14 sys-

tems with 10 groups per system. The radio has such standard features as system and group scan, talkaround and User Select menu-driven operation.

Circle (417) on Fast Fact Card

#### Directional yagi antennas feature aluminum boom, solid rod elements

Heavy-duty directional yagi antennas covering several ranges are available from Comtelco Industries. range from five-element, 9dBd gain antennas for 144MHz-225MHz to 10element, 12.2dBd gain antennas for 800/ 900MHz. The antennas are constructed with an aluminum U-channel boom and solid aluminum rod elements. A polyester coating provides protection from the environment.

Circle (418) on Fast Fact Card

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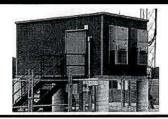
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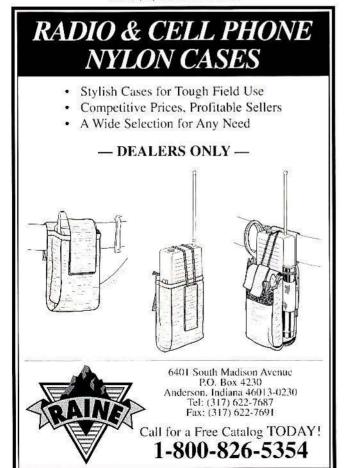
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#### Circle (60) on Fast Fact Card

#### New products

#### Matched portable/mobile units offer dual-mode use



The LTS 2000 portable and LCS 2000 mobile radios from Motorola Land Mobile **Products Sector** are dual-modecapable and offer as many as 90 modes on trunked and conventional channels. The radios share common

software features to simplify operation and to reduce training time. Both operate in the 821MHz-824MHz range for NPSPAC and trunking. APCO 16 features are incorporated, including emergency, PTT ID, selective inhibit and dynamic regrouping. Backlit displays show status icons for easy readability. The portables offer an eight-character display, four-by-four keypad and emergency side button.

Circle (419) on Fast Fact Card

#### Time domain reflectometer indicates fault severity

Advanced Electronic Application's CableMate time domain reflectometer locates faults in coaxial and two-wire cables. The unit graphically indicates the severity of faults and the distance to the fault. Distances to 2,000 feet can be displayed in feet or meters along with the amplitude in decibels from the injected pulses. The hand-held unit is batterypowered and offers on-screen menus and on-screen help for almost all functions. As many as 15 plots and their parameters can be saved in non-volatile memory for later reference. Each plot can be assigned an identifying name that will appear each time the plot is displayed. Optional soft-



ware links the CableMate to a PC for real-time remote control and display.

Circle (420) on Fast Fact Card

#### Circuit repair kits speed modification of connectors



Pace's four Thermo-Bond Cir-Kits allow fast repair and modification of SMT lands and Thru-Hole pads, edge connector fingers and other circuitry to original manufacturer specifications. The Cir-Kit frame uses a dryfilm adhesive backing that can be hot-bonded in 15 seconds at low temperatures. Twelve ThermoBond Selector frames are available.

Circle (421) on Fast Fact Card

#### Panel-mount receptacles replace Type N connectors



TRU-7666/7686 panel-mount receptacles are 7/16 female and male direct replacements for Type N connectors that eliminate the need for panel modification. Designed to ensure low intermodulation, the recep-

tacles from **Tru-Connector** provide  $50\Omega$  impedance and are rated for 2,700Vrms. The units have either gold or silver center conductors, BeCu contacts and Teflon insulators.

Circle (422) on Fast Fact Card

#### Power supply allows direct input from dc sources

Avtec offers an optional 48Vdc input power supply for its DSPatch series of radio-telephone console systems. The option allows direct input from dc voltage sources common in most telephone equipment rooms, without resorting to dc-to-ac converters. The redundant power supplies operate in a load-sharing configuration with no system down-time in the event of power loss from either supply. Output voltages, monitored by 5V and 12V sense lines, are passed to the system for diagnostic monitoring. System controllers activate an alarm message at the operator workstations and the system printer if a failure is detected. DSPatch is a high-capacity switching system featuring extensive use of digital signal processors.

Circle (423) on Fast Fact Card

#### Modified transceiver modem has repeater capability

RF Neulink's 2W Neulink 9600 transceiver modem has repeater capability. With 65,000 unique ID codes, the synthesized UHF modem is capable of point-to-point and point-to-multipoint networking. The full handshake protocol includes RTS, CTS, DSR, and DCD as well as error detection and correction.

Circle (424) on Fast Fact Card

#### Radio-telephone interface includes auto-answer

The RTU-282 radio-telephone interface unit from JPS Communications includes a built-in telephone and a handset that can both be used in-



dependently. The unit features auto-dial and auto-answer capabilities, built-in digital signal processing and vox capability. Circle (425) on Fast Fact Card

#### Waterproof connectors install without special tools

RFS Cablewave Systems has introduced the Self-Clamp <sup>1</sup>/<sub>2</sub><sup>n</sup> Superflex connectors that are designed to be waterproof, solderless and easy to install. No special tools are required. Cablewave Systems also offers Flexwell low-loss foam cable, air-dielectric cables, radiating cables, point-to-point microwave antennas and waveguides.

Circle (426) on Fast Fact Card



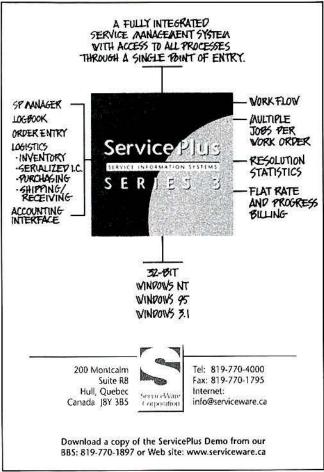
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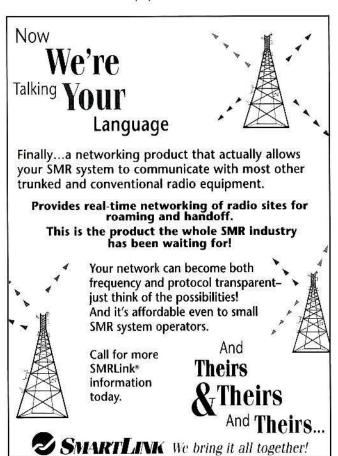
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Circle (62) on Fast Fact Card

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Circle (63) on Fast Fact Card



#### New products

#### Flat patch array PCS antennas are less than 2" thick



CSS Power has released a PCS antenna line. The flat patch array family of antennas feature pseudo-microstrip-fed, aperture-coupled (AC) patches using ceramic-filled laminate substrate construction. All antennas are less than 1.7" thick, with various lengths proportioned according to antenna gain. This AC series also includes dual-polarized antennas that use orthogonal slant, 45° polarization. The CSS antenna mechanical package is designed for, and verified against, MIL-STD-810E. All antennas are also covered with a five-year warranty.

Circle (427) on Fast Fact Card

#### Smart radios provide easier mobile roaming

Zetron offers software upgrade kits for existing model 49/ ZX controllers, and the company is shipping new controllers with Uniden's ESAS protocol included. By adding new software to existing Zetron controllers, system operators can offer new features to their customers and streamline their own network. Unique IDs, electronic serial numbering in each mobile, deadbeat disable, auto registration and wide-area roaming are some of the enhancements. The new software in mobile radios equipped with E.F. Johnson's LTR protocol allows roaming to different systems by just dialing the number and pressing the send key. When connected to the Zetron network switch, radios provide multiple site dispatch, voice messaging and onenumber calling.

Circle (428) on Fast Fact Card

#### RNet-compatible modem facilitates data transfer

The DL-3276 RNet-compatible modem from E.F. Johnson's Telemetry Division allows data communications between Johnson telemetry products and other RNet radio-modems. The modems are factory-installed with Johnson telemetry radios: either the DL-3412 or DL-3476, which cover the full UHF band with



25kHz, 12.5kHz and 6.25kHz channel steps; or the DL-3422, which operates in the full VHF band with 30kHz, 15kHz and 7.5kHz channel steps. The modem offers several data rates.

Circle (429) on Fast Fact Card

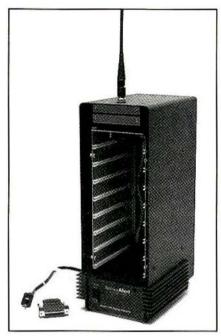
#### Repeaters cover cellular and SMR applications

The cellular repeater 48610 from Celwave is designed to cover the A and B cellular bands and improve cellular service in parking garages, office buildings and RF-shielded environments. The 48610 is compatible with analog and digital service and can be used as a stand-alone repeater or as an in-line booster for Celwave's enhanced bi-directional amplifier or a microcell. The repeater is designed to improve SMR band 806MHz-824MHz and 859MHz-861MHz RF-isolated areas by repeating the TX signal from the base and simultaneously repeating the mobile signal back to the base. This model can be used as a stand-alone repeater or as an in-line booster for a microcell or in-house RF communications system.

Circle (430) on Fast Fact Card

1269 South Broad Street, Wallingford, CT 06492 1-800-229-LINK Fax. 203-269-5475

#### Paging tower expands possibilities for on-site wireless communications



ServiceAlert's 7100M paging tower is a UHF wireless messaging transmitter that enables a device with an external comm port to send full text messages within 3 seconds. The tower supports 2 million cap codes and can be configured with telephone interconnect; serial, contact-closure, button interface and modem interconnect boards; or any combination of eight boards.

Circle (431) on Fast Fact Card

#### Mount combines vinyl-clad steel shaft with rotation-tilt assembly



Electro-SMC Mount's vinyl-clad Uni-Lok mount series incorporates a flexible, vinvlcovered steel shaft with SMC's Uni-Lok assembly, providing 360° rotation and 180° of tilt for positioning and securing communications equipment. The mounts are designed with a large set screw for stability. The mount base is triangular, allow-

ing both flat and right-angle installation. Heights of 7", 9", 10", 11", 13" and 15" are available.

Circle (432) on Fast Fact Card

#### New cable hardware design simplifies installation with spring connection

Andrew's connectors for 1/8" foam dielectric cable install easily, comparable to a spring finger connection. A coarsely threaded inner contact pin reduces the number of rotations required to attach the pin to the inner conductor by 75% for quicker installations. The threaded inner stub provides a strong, reliable mechanical connection that will not pull off easily and yields good intermodulation performance.

Circle (433) on Fast Fact Card



#### Automatic station identifier retains call sign without battery backup

The model 1402V automatic voice station identifier from Racom Products identifies transmitters automatically with a recorded voice call sign. The unit does not need battery backup or power to retain its user-recorded call sign, which is field-recorded into non-volatile EEPROM with a mic.



Circle (434) on Fast Fact Card

#### Dual-deck voice-logger offers simultaneous archiving, traffic replay

Racal Recorder's dual-deck Wordwatch voice-logger allows unattended recording of voice communications across four channels for as long as 12 hours. Two drives allow the logger to operate in parallel, sequential or autocycle modes. In parallel recording mode, one tape can be used for continuous archiving while the other tape is used for immediate tactical replay. Features include time stamping, and time or message search modes. A four-position switch allows the



systems to be secured in the record mode.

Circle (435) on Fast Fact Card

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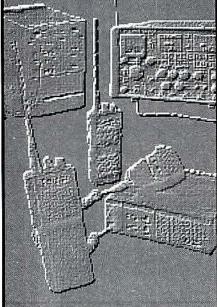
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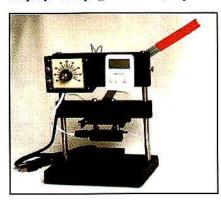
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#### New products

Mounting machine securely bonds displays for pager service, repair



Linktronic System's Mounting Machine is an LCD-bonding system for pager service and repair operations. The unit provides close-loop variable temperature control, positive pressure and an automatic countdown timer. Motorola's Bravo, Bravo Lifestyle, Bravo Classic, Bravo Plus, Bravo Plus Lifestyle, Bravo Express and Memo Express pagers can be repaired with the provided scating nest.

Circle (436) on Fast Fact Card

#### Hand-held is factory-programmed with 5 frequencies, 148MHz-174MHz



The PROCOM M520 is a 5W, highpower, miniature VHF hand-held programmable transceiver. All units come factory preprogrammed with five VHF frequencies. Additional frequency changes can be made using the CPK-520 programming kit, which contains a floppy disk program and interface cable to connect

to any computer printer port. The CCK-520 cable clones frequencies from one preprogrammed unit to another. Fanon Courier's PROCOM M520 remains weather-resistant in its die-cast aluminum frame and high-impact case. Other features include a 20-channel selector, digital channel readout, power switch, channel lockout, tone- and digital-controlled squelch, scan/priority indicator and timeout indicator. The unit includes a rechargeable NiCd battery pack, ac battery charger, antenna with BNC connector and FCC license application.

Circle (437) on Fast Fact Card

#### Multiple-beam array antenna operates at 824MHz-894MHz

Andrew's SmartBeam multiple-beam array antenna improves carrier-to-interference ratio, talkback link margin and increases coverage area. The unit operates in the 824MHz-894MHz cellular band.

Circle (438) on Fast Fact Card



#### istribution

Allen Telecom Group, Cleveland, selects Arva-Hudson, Seattle, and Sales Associates, Minneapolis, as manufacturer's representatives for antenna products from its Antenna Specialists Division and Decibel Products Division. Arva-Hudson's territory includes Washington, Oregon, Alaska and the western sections of Idaho and Montana. Sales Associates' territory includes North Dakota, South Dakota, Minnesota and western Wisconsin.

For more information, call 216-349-8400

Hutton Cellular Division of Hutton Communications, Dallas, offers POP packaging for leather cases, batteries, battery eliminators and holders consisting of durable, transparent clamshell plastic packaging with blue and green backcards, boldly labeled by product type.

For more information, call 214-239-0580

Antennaco, Milford, NH, selects IBEX Systems, Bloomington, IL, and Englehardt & Associates, Laconia, NH, as manufacturer's representatives for its complete line of wireless communications antennas. IBEX's territory includes Wisconsin, Illinois, Indiana and Michigan. Englehardt's territory includes Maine, New Hampshire, Vermont, Massachusetts, Rhode Island and Connecticut.

For more information, call 603-673-3153

Motorola Americas Parts Division, Schaumburg, IL, distributes high-energy lithium/iron disulfide 1.5V "AA" batteries, for pagers and other equipment, manufactured by Everyready Battery, Cleveland.

For more information, call 800-543-9191

Hanwa American, New York, imports and distributes the model-specific Logical Power Charging System for NiCd and NiMH batteries used in Motorola, Nokia and nine other makes of cellular phones.

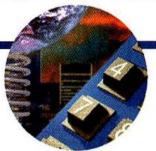
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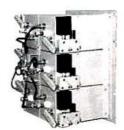
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# eople







Singer

Changes at Celwave, Marlboro, NJ:

Andy Singer leaves Allen Telecom, Cleveland, as marketer of the antenna product line to join Celwave as director of technical marketing.

Andrew Crowley departs CANAC Telecom, Toronto, as marketing program director to become Smart System product manager at Celwave's Phoenix location.

Chris Seyer, executive vice president for Power Conversion Products, Crystal Lake, IL, advances to president, succeeding Edward S. Weil, who becomes chairman of the board of directors.

Scot Nelson exits Industrial Ventilation, Nampa, ID, as vice president of marketing and sales to join Western Communications. Boise, ID, as general manager, replacing Robert Horting, who retires after 28 years of service.

Changes at IFR Systems, Wichita, KS:

Joseph Hartmann leaves Izumi Corporation, Long Island, NY, as head of human resources to join IFR Systems as director of human resources.

Dennis Coley departs Learjet, Wichita, as the corporate controller and assistant treasurer to become the RF division controller for IFR.

Alan Li, director of engineering for Comsearch, Reston, VA, advances to vice president of wireless engineering.

W. Bruce Quackenbush Jr. leaves Pride of Baltimore as executive director to join Tessco Technologies, Sparks, MD, as head of corporate development.

Thomas R. Nutt exits Apex, Dallas, as account executive to join DFW Communications, Richardson, TX, as sales manager for its land mobile radio facilities in the Dallas/Fort Worth area.

Treana "T" Tober departs Hutton Communications, Dallas, as northwest regional sales manager to become western regional sales manager for Allen Telecom Group, Cleveland. She is based in Kirkland, WA.

Donald J. Catledge, director of the Neulink Division for RF Industries, San Diego, advances to president of the division.

PCIA, Alexandria, VA, industry award winners:

Al Gross, senior principal engineer at Orbital Sciences, receives the Pioneer Award.

J. Barclay Jones, vice president of engineering for American Personal Communications, receives the Technology

Jeffrey Vaessen, applications engineer for Hark Systems, receives the Technician of the Year Award.



# Paging market studies outline industry conditions and emerging trends

Two studies from MTA-EMCI project paging trends. World Paging Markets: 1996 describes trends contributing to the global growth of paging. The study includes projections of paging subscribers by country through 2001, trends by type of pager, system manufacturer installations, equipment sales projections and new technologies. The

State of the U.S. Paging Industry; 1996 provides an in-depth analysis of the emerging industry trends occurring in the United States. The study outlines current industry conditions, and this year's study features an expanded profile of the major paging carriers and an analysis of the demand for two-way text messaging services.

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# First book in radio communications series addresses HF technology

Radio Communications in the Digital Age, Volume One: HF Technology is the first volume in a series of books covering modern radio communications. The 101page book published by Harris RF Communications covers basic concepts of HF radio propagation, describes HF radio equipment, discusses techniques for overcoming noise and interference, and examines adaptive radio technology.

Circle (251) on Fast Fact Card

# Data sheet for cable, antenna analyzer stresses preventive maintenance

The Site Master data sheet from Anritsu-Wiltron emphasizes preventive maintenance techniques for improving antenna system quality and reducing maintenace costs. Performance in this regard is compared to the capabilities of metallic time domain reflectometry, which only serves a fix-after-failure role. Features of the Site Master cable and antenna analyzer include accurate return loss or SWR, high RF interference immunity and wattmeter option.

Circle (252) on Fast Fact Card

# Bulletin board system improves customer service

Celwave's bulletin board system (BBS) is designed to better serve its customers. It features digitized patterns, software and bulletins. Users have access to Celwave's digitized antenna patterns and antenna pattern reader. Software programs can be downloaded and messages can be left for sales engineers regarding products and systems engineering issues. The BBS operates as high as 28.8kbs and uses standard modem settings of 8-N-1.

Circle (253) on Fast Fact Card

### Catalog covers wireless telemetry

The free 28-page catalog from RF Neulink features crystal-controlled and synthesized wireless transceivers, transmitters and receivers. Also featured is the SkyLine RTU, a digital and analog data acquisition and control module, that has a standard configuration of eight digital I/Os, two analog inputs, a synthesized UHF transceiver and intelligent modern.

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# etters from readers

### Tunnel radio communications:

With all due respect to Dr. Peter Mailandt's article in the July 1996 issue of Mobile Radio Technology, "Boston Breaks New Ground on Tunnel, Radio Communications," this "new ground" has been broken by others long before the Boston Harbor tunnel project.

The Los Angeles Subway Radio system supports 20 channels (40 frequencies) of two-way radio communications spread over 160MHz through 860MHz bands. The Interstate Highway 90 Baker tunnel in Seattle supports 16 channels of twoway radio plus rebroadcasts the complete AM and FM commercial radio bands.

Both of these systems, and we're sure there are others, have been in service several years now.

> Sincerely Yours, Michael H. Albert Parsons Brinckerhoff Edwin L. Haynes ICF-Kaiser

Dr. Mailandt's reply:

In answer to the Mr. Albert and Mr. Haynes' comments concerning the complexity of the Boston Harbor Tunnel radio communications project compared to other previously installed systems. I felt that we were breaking new ground by having 31 two-way channels (62 frequencies) all providing coverage along the entire length of the Ted Williams Tunnel. The concept certainly is not new; however, the sheer number of frequencies involved significantly increases the possibilities for degradation and interference.

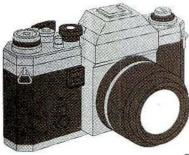
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We want to hear your ideas and suggestions regarding Mobile Radio Technology. Please submit your letters to: Don Bishop, Editorial Director Mobile Radio Technology 9800 Metcalf Ave. Overland Park, KS 66212

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We are interested in photographs of facilities, installations or other graphic material relevant to the audience we serve. We welcome material from vendors, consultants, dealers, technicians, service-providers, end-users and others.

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consideration for our cover, please let us know. We would love to hear from you!

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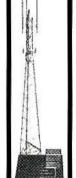
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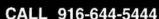
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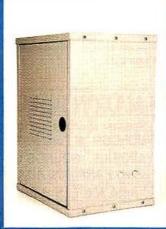
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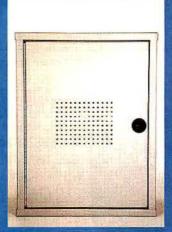
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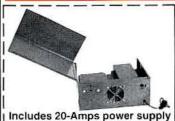
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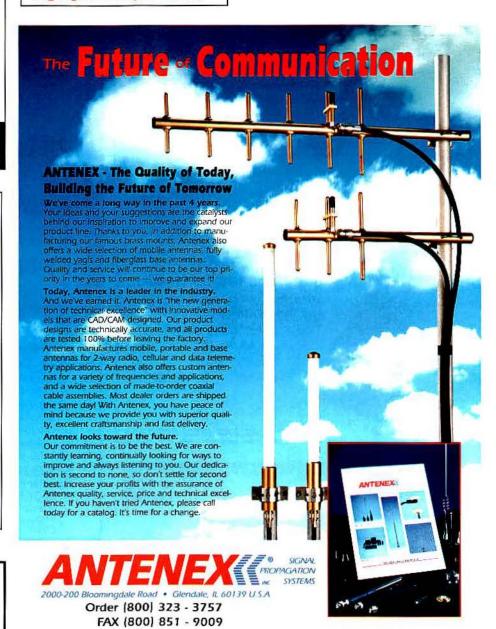
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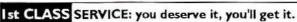
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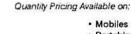


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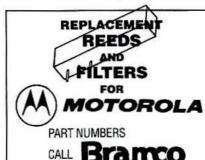
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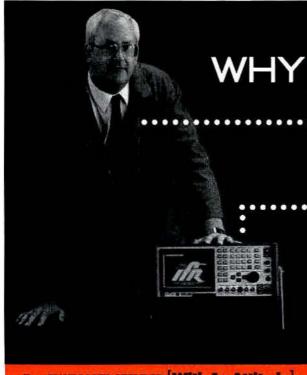
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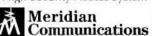
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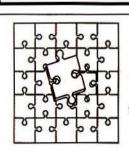
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